

**DEPARTMENT OF ENERGY**  
**FY 1999 CONGRESSIONAL BUDGET REQUEST**  
**ENERGY CONSERVATION**  
**(Tabular dollars in thousands, Narrative in whole dollars)**

**BUILDING TECHNOLOGY, STATE AND COMMUNITY SECTOR**

**PROGRAM MISSION**

Residential and commercial buildings use 33 quadrillion Btus (quads) of primary energy annually. This represents more than a third of total U.S. energy consumption, and accounts for two thirds of all electricity used in the country. This energy costs building owners and operators over \$220 billion each year. Because utility bills are a substantial part of family budgets, residential building energy use affects what kind of housing we can afford and how comfortable and healthy we are at home. Energy use in the commercial sector represents a cost to business and can have a substantial bearing on employee health and productivity.

Energy consumption in buildings has serious environmental implications. Carbon dioxide emissions attributable to buildings energy use in the U.S. constitute 35% of the national total. In addition, energy use in buildings is responsible for 47 percent of U.S. sulfur dioxide emissions and 22 percent of nitrogen oxide emissions, making building energy use a major cause of acid rain and smog in our communities. The Energy Information Administration projects that, if unimpeded, annual energy consumption in the buildings sector will increase to 38 quads by the year 2015.

**Buildings for the 21<sup>st</sup> Century**

The buildings energy industry is entering a period of complex challenges brought about by two major trends: technological innovation and electric utility restructuring. As the marketplace for energy opens up to competition, new technology applications and market-driven utility rates could engender an exciting range of energy-efficient building services and equipment, such as interactive communications and controls, integrated power generation, advanced materials and “smart appliances”. Also, technology developments outside the traditional building markets--telecommunications, fiber optics, construction efficiency, etc.--could be adapted to building energy systems. The ability to adapt, integrate, and deploy the steadily growing range of technology options will be key to improving the efficiency of new and existing buildings.

There is also a continuing need for action in the context of existing technologies. Implementation or deployment of cost-effective technologies can often be greatly delayed by user uncertainties, such as life-cycle cost, long-term performance, safety or other product attributes. Facilitating the deployment of recent technological advances, including creative applications of existing technologies, is therefore critical to reaping the benefits of R&D. Analysis of existing technologies also provides a valuable feedback loop to the next generation of products.

## **PROGRAM MISSION - BUILDING TECHNOLOGY, STATE AND COMMUNITY SECTOR (Cont'd)**

No single builder, manufacturer or other member of the construction industry is prepared or can afford to undertake alone the complex integration and deployment challenges ahead. Without DOE as facilitator and participant in cooperative arrangements, many energy-efficient technologies are not likely to be used in the buildings sector for many decades. DOE and partners need to plan, guide, facilitate, and implement the transition to more efficient technologies.

In order to respond to the changing environment and to better serve customer needs, a major effort is currently underway to create a vision and action plan for the buildings program. This effort is being referred to as *Buildings for the 21<sup>st</sup> Century*. The *Buildings for the 21<sup>st</sup> Century* strategic planning process brings together the collective genius of the design, construction, and investment industries. The *Buildings for the 21<sup>st</sup> Century* activity will be used to advance the “whole-buildings” approach to achieving a lasting transformation of the energy efficiency delivery system in buildings. The whole-buildings approach involves a consideration of all phases of the building process (design, construction, operation, maintenance, financing, insurance, retrofit/renovation, and demolition), engagement of all participants (designers, builders, code officials, owners, building managers, developers, investors, building product manufacturers and suppliers, and other members of the construction industry), as well as the optimal integration of building materials, equipment, and systems which has traditionally been the focus of DOE’s research and development programs.

The *Buildings for the 21<sup>st</sup> Century*’s whole-buildings approach represents a “new way of thinking” to be used in coordinating current and future buildings programs. The strategic plan itself will identify approaches and necessary actions that will require implementation strategies to simplify and focus the program priorities. More importantly, however, the strategic planning process and the permanent feedback mechanisms built into the whole-buildings implementation approach will continuously stimulate dialogue between the research community (government labs and industry researchers) and those who are ultimately responsible for buildings design, construction, and operation. The existence of a customer-focused, integrated, and dynamic buildings strategy will enable smooth technology transfer and accelerate the adoption of new technologies. Industry partnerships to develop technology initiatives, peer review and competitive solicitations for R&D are also integral to this new way of doing business.

Two *Buildings for the 21<sup>st</sup> Century* workshops have already been held where a “blue ribbon” group of public, private, nonprofit, and community leaders were invited to participate in creating the first vision and action plan around the “whole buildings” concept. These workshops were but the first steps in a continuing effort to improve the focus of the buildings programs. In the upcoming months, additional meetings will be held in order to develop technology visions and R&D roadmaps to guide the Department’s future efforts and to help in tracking and evaluating the progress of all programs. Already, the residential and commercial buildings agendas are being reviewed to define the adjustments that are needed to accelerate the adoption of the *Buildings for the 21<sup>st</sup> Century* whole-buildings approach as defined by our stakeholders. Throughout the process, both Codes and Standards and State and Community Programs will be closely coordinated.

## **PROGRAM MISSION - BUILDING TECHNOLOGY, STATE AND COMMUNITY SECTOR (Cont'd)**

### **Vision - Buildings for the 21<sup>st</sup> Century**

In the 21<sup>st</sup> century, people have higher expectations for the buildings in which they live, work, learn, and play. Good buildings provide comfort and convenience, are energy and resource efficient, are of high quality and durable, enhance health and productivity, are simple to operate and disaster resistant, generate at least a portion of their own power, and yet are affordable. Good buildings also protect those qualities in the buildings and community around them. The buildings industry, the financial community, and government policy makers have responded to these higher expectations by developing and capitalizing on the “whole-buildings” concept. As a result, U.S. industry is the leader in the global marketplace for construction and efficiency products and services. Simply stated, the vision of the Office of Building Technology, State and Community Programs (BTS) is a healthier, more prosperous future through the wise use of energy in buildings and communities.

### **Mission**

It is the mission of the Office of Building Technology, State and Community Programs in partnership with industry and government, to develop, promote, and integrate energy technologies and practices to make buildings more efficient and affordable, and communities more livable. This involves (1) supporting the development of new, cost-effective, and environmentally sound technologies for buildings in cooperation with industry and the scientific community; (2) bringing these technologies to market working with private and public sector partners; (3) ensuring broad access to these technologies by expanding market availability and informed consumer choice; (4) establishing cost-effective building and appliance codes and standards; (5) coordinating Federal efforts with state and local governments; and (6) providing direct investment and technical support to weatherize homes of low-income families.

### **Goal and Objectives**

The goal of the Office of Building Technology, State and Community Programs is to cost-effectively limit non-renewable energy use in buildings by improving the energy efficiency of buildings and equipment and by expanding the role of renewable energy in buildings. Specific objectives are: (1) to cost-effectively maintain energy consumption from non-renewable sources at the current level of 32 quads, accommodating the predicted growth in population, GNP, and standard of living; and (2) to double, by the year 2015, the application of solar and other renewable energy sources to buildings.

### **Benefits**

Detailed analysis indicates that successfully achieving the program goals will result in total energy savings ranging from 1.41 to 2.04 quads by the year 2010. For consumers this represents a potential net savings of \$10 billion in energy costs for the year 2010 alone. Energy cost savings may be spent by consumers to improve their quality of life, which generally involves expenditures on more labor-

## **PROGRAM MISSION - BUILDING TECHNOLOGY, STATE AND COMMUNITY SECTOR (Cont'd)**

intensive goods and services, which will stimulate economic growth and lead to job creation. Additional benefits will accrue from the avoided construction costs of 18 gigawatts of power generation capacity, an investment estimated at \$12 billion.

Other benefits include a reduction in atmospheric carbon emissions of up to 45 million metric tons annually by 2010 with corresponding reductions in the emissions of sulfur dioxide and nitrogen oxides. In addition, the development of advanced buildings technologies will help the U.S. maintain its role as a leading exporter of such technologies.

### **Strategy**

The Department implements a strong, multifaceted portfolio of programs to encourage cost-effective investments in energy efficiency. Consistent with a whole-buildings approach, the programs are designed to synergistically capture the benefits of four implementation strategies: research, development and demonstration; market deployment; minimum efficiency standards for new buildings and appliances; and State and local partnerships. These strategies are carried out through programs that address these areas: building equipment and materials, building systems, codes and standards, and state and local partnerships.

Our work in building equipment and materials focuses on building components such as light sources, appliances, insulating materials and windows. The program implements a balanced and integrated approach that links parallel streams of research, development, demonstration, and deployment activities. Through cooperative efforts, opportunities are created to dramatically improve the performance of building components and accelerate their adoption in new construction and renovation/replacement applications. Research and development activities consist largely of longer-term industry cost-shared projects. Project objectives include improving the cost/performance characteristics of existing technologies; developing new, cutting-edge technologies; demonstrating the reliability and functionality of advanced technologies; and establishing U.S. industry technology positions needed to maintain technology leadership in international markets. Deployment activities, such as the ENERGY STAR program, capitalize on R&D technical innovations and complement the appliance codes and standards program by targeting consumers who can benefit from technologies that are more efficient than required by minimum compliance levels.

Our work in building systems focuses on whole-buildings integration. Research and development activities include the development of design tools and strategies to optimally integrate building components, manufactured sub-assemblies, and equipment into whole-buildings. Within building systems, Building America (residential) and Rebuild America (commercial and multi-family) are the capstone initiatives of the *Buildings for the 21<sup>st</sup> Century* strategy. Building America and Rebuild America integrate building component and systems R&D efforts with deployment activities through the formation of partnerships with organizations having a stake in the buildings industry. These partnerships foster synergism and focus R&D efforts on those technology needs and opportunities that are identified in the design, construction, operation, and retrofit of highly efficient showcase buildings and widespread applications.

## **PROGRAM MISSION - BUILDING TECHNOLOGY, STATE AND COMMUNITY SECTOR (Cont'd)**

The Codes and Standards program implements the legislatively mandated, multi-year effort to improve the energy performance of building equipment, appliances, and construction practices. The program is carried out through two activities; building standards and guidelines, and lighting and appliance standards. The building standards activity notably assists States in updating their mandatory and voluntary energy codes. The lighting and appliance standards program includes appliance testing, labeling, and mandatory energy conservation standards. The Codes and Standards program is a key contributor to the BTS strategy as it serves to displace the most inefficient products and practices from the market. Efficiency levels are established so that they are cost-effective for the vast majority of consumers and reflect a broad consensus of opinion among builders, manufacturers, and other stakeholders. Voluntary standards, test procedures, and labeling activities increase consumer awareness so that they are more likely to consider more efficient alternatives. They also provide benchmarks for the development of market deployment initiatives such as ENERGY STAR.

State and Local Partnership programs promote energy efficiency and the adoption of renewable technologies among States, municipalities, institutions, and private citizens. State, local, and community partnerships are essential elements to providing education, weatherization, and other whole-building services. In particular these programs extend the benefits of energy efficiency technologies and practices to families at all income levels. They augment the *Buildings for the 21<sup>st</sup> Century* strategy by incorporating a state and local perspective to focus R&D agendas, deployment activities, and codes and standards development.

Through the *Buildings for the 21<sup>st</sup> Century* process and a wide range of additional activities, the Department will ensure that all its buildings programs reflect the BTS program's mission and goals and are responsive to the needs of its customers. Incorporated in this new way of doing business are two major new thrusts: a commitment to increase the amount of research dedicated to competitive solicitations, and; an improved peer and program review process to measure the quality and effectiveness of ongoing programs.

### **FY 1999 Budget Request**

Working side-by-side with its customers, BTS is in the process of creating a new vision to serve as a basis for program development and implementation plans. The FY 1999 budget reflects the ongoing transition of the Department's building agenda towards a more focused "whole-buildings" approach that incorporates important component-based research initiatives and new industry partnerships. Complete implementation of the *Building for the 21<sup>st</sup> Century* strategy will be apparent in future BTS budget requests.

DEPARTMENT OF ENERGY  
FY 1999 CONGRESSIONAL BUDGET REQUEST  
ENERGY CONSERVATION  
(Dollars in thousands)

PROGRAM FUNDING PROFILE

Building Technology, State, and Community Sector

Activity	FY 1997	FY 1998	FY 1999	FY 1999	Program Change Request vs. Base	
	Enacted	Enacted	Base	Request	Dollar	Percent
Building Systems Design Operating Expenses .....	\$ 23,255	\$ 22,986	\$ 22,986	\$ 36,373	\$ 13,387	58%
Building Equipment and Materials Operating Expenses .....	\$ 26,080	\$ 26,921	\$ 26,921	\$ 46,181	\$ 19,260	72%
Codes and Standards Operating Expenses .....	\$ 11,810	\$ 14,423	\$ 14,423	\$ 22,573	\$ 8,150	57%
State and Local Partnership Programs Operating Expenses .....	\$ 151,421	\$ 156,695	\$ 156,695	\$ 197,700	\$ 41,005	26%
Management and Planning Operating Expenses .....	\$ 17,333	\$ 12,850	\$ 12,850	\$ 14,718	\$ 1,868	15%
Capital equipment .....	\$ 0	\$ 0	\$ 0	\$ 0	\$ 0	0%
Subtotal, Management and Planning	\$ 17,333	\$ 12,850	\$ 12,850	\$ 14,718	\$ 1,868	15%
TOTAL .....	<u>\$ 229,899</u> <sup>a/</sup>	<u>\$ 233,875</u>	<u>\$ 233,875</u>	<u>\$ 317,545</u>	<u>\$ 83,670</u>	<u>36%</u>
Summary						
Operating Expenses .....	<u>\$ 229,899</u>	<u>\$ 233,875</u>	<u>\$ 233,875</u>	<u>\$ 317,545</u>	<u>\$ 83,670</u>	<u>36%</u>
Total Program .....	<u>\$ 229,899</u>	<u>\$ 233,875</u>	<u>\$ 233,875</u>	<u>\$ 317,545</u>	<u>\$ 83,670</u>	<u>36%</u>
Staffing (FTE's)						
HQ FTEs .....	81	74	74	75		
Field FTEs .....	0	0	0	0		
Total FTEs .....	<u>81</u>	<u>74</u>	<u>74</u>	<u>75</u>		

PROGRAM FUNDING PROFILE: Building Technology, State, and Community Sector (Cont'd)

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a/ Reflects adjustment for approved reprogrammings 97-R-12 of \$-1,060.0 thousand for the Small Business Innovative Research Program (SBIR) and \$-83.7 thousand for the Small Business Technology Transfer Pilot Program (STTR) activities.

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Authorizations:

P.L. 94-163, "Energy Policy and Conservation Act" (EPCA) (1975)

P.L. 94-385, "Energy Conservation and Production Act" (ECPA) (1976)

P.L. 95-91, "Department of Energy Organization Act" (1977)

P.L. 95-618, "Energy Tax Act of 1978"

P.L. 95-619, "National Energy Conservation Policy Act" (NECPA) (1978)

P.L. 95-620, "Powerplant and Industrial Fuel Use Act of 1978"

P.L. 96-294, "Energy Security Act" (1980)

P.L. 100-12, "National Appliance Energy Conservation Act of 1987"

P.L. 100-615, "Federal Energy Management Improvement Act of 1988"

P.L. 101-218, "Renewable Energy and Energy Efficiency Technology Competitiveness Act of 1989"

P.L. 102-486, "Energy Policy Act of 1992"

DEPARTMENT OF ENERGY  
FY 1999 CONGRESSIONAL BUDGET REQUEST  
ENERGY CONSERVATION  
(dollars in thousands)

SUMMARY OF CHANGES

Building Technology, State, and Community Sector

FY 1998 Enacted .....	\$ 233,875
- Non-Discretionary .....	0
FY 1999 Base .....	\$ 233,875

Building Systems Design

- Residential Buildings - The increase will add five new 200 home Building America communities a "zero energy" systems approach, and design tools incorporating lessons learned from Building America. ....	5,595
- Commercial Buildings - The increase increases the number of Rebuild America partnerships from 55 to 85, makes awards to industry-led consortia for whole-building commercial R&D, and expands efforts with industry to integrate energy performance with building-related software .....	7,792

Building Equipment and Materials

- Technology Roadmaps and Competitive R&D - The increase supports competitive R&D directed by industry input	8,000
- Space Conditioning and Cogeneration - The increase supports enhanced R&D for natural gas technologies: desiccants and fuel cells .....	2,950



## SUMMARY OF CHANGES - Building Technology, State, and Community Sector (Cont'd)

- Lighting and Appliance - The increase accelerates research on compact fluorescent lamps, novel light distribution systems, and lighting controls and impacts, and expands the Technology Introduction Partnership "TIP's" program into commercial buildings technologies and incorporates more gas products . . . . .	5,738
- Building Envelope R&D - The increase is for R&D in environmentally R&D benign agents to replace chlorofluorocarbons and research in electrochromics and advanced glazings for windows . . . . .	2,572
<u>Codes and Standards</u>	
- Building Standards and Guidelines - The increase supports efforts to increase ease in compliance and new codes .	4,530
- Lighting and Appliance Standards - The increase supports standards for additional products . . . . .	3,620
<u>State and Local Partnership Programs</u>	
- Weatherization Assistance Program - The increase supports weatherization of nearly 15,000 more low-income homes than in FY 1998 . . . . .	29,255
- State Energy Program - The increase supports state energy program priorities and reinforces state infrastructure .	6,750
- Competitive Energy Partnerships - The increase supports new Competitive Energy Partnerships incorporating technology, financing, training, and other novel approaches to incorporating energy efficiency in communities . . .	5,000
<u>Management and Planning</u>	
- Evaluation and Planning - The increase supports GPRA analysis and the design and implementation of a program evaluation process . . . . .	1,768
- Program Direction - The increase supports one additional FTE . . . . .	100
FY 1999 Congressional Budget Request . . . . .	<hr/> \$ 317,545

BUILDING TECHNOLOGIES  
BUILDING TECHNOLOGY, STATE, AND COMMUNITY SECTOR  
(dollars in thousands)

BUILDING SYSTEMS DESIGN

**I. Mission Supporting Goals and Objectives:**

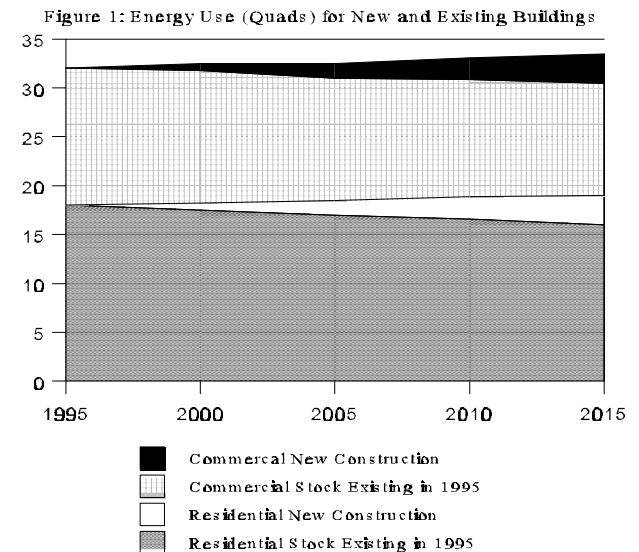
The mission of the Building Systems program is to dramatically improve the overall energy efficiency and environmental quality of the Nation's commercial and residential buildings by improving the integration of building energy systems.

The Building Systems program accomplishes its mission by bringing together the technology specific BTS programs such as energy efficient equipment, lighting, and structure components, with system technologies such as electronic controls and automated construction processes. The result is a comprehensive program that investigates, develops and promotes the optimal mix of these technologies to accomplish whole buildings energy excellence.

**Market Segments and Customers**

The program's activities are divided along the lines of the two main energy-consuming building sectors: residential and commercial buildings. This segmentation reflects the very different institutional, technical and financial challenges that must be overcome to improve energy efficiency in each sector.

Building markets are further divided into new construction and retrofit categories due to important differences in needs and opportunities for energy savings. There were 83 million buildings present in the nation in 1995 and it is expected that 27 million new buildings will be constructed in the 1995-2015 time-frame. On an individual building basis, the opportunity for cost-effective energy savings is greater in new construction than it is in retrofit applications—50% compared to 20%. However, existing buildings represent a larger segment of the total building market. Figure 1 illustrates why it is important for DOE to be present in both activities. Although new construction savings are greater on a per-unit basis, most of building energy use in 2015 will be from buildings built before 1995. The short-term savings from retrofit improvements complement the long-term savings that arise from improved new construction practices and provide a steady stream of energy savings.



## I. Mission Supporting Goals and Objectives: BUILDING SYSTEMS DESIGN (Cont'd)

### Program Strategy

To service the building segments previously described, the Building Systems program supports a unique mix of research, development and deployment RD&D activities for each segment. The role and emphasis of RD&D initiatives is adapted to ensure limited resources are channeled to areas of greatest cost-effectiveness. In the residential sector, the program's efforts have been directed primarily to new construction and systems R&D. The highly fragmented nature of the residential construction industry—comprised of over 160,000 homebuilders—has inhibited the development of a strong industry-led R&D agenda. In the existing institutional framework no builder can afford to develop alone the analytical tools and system elements needed to optimize whole-building performance.

**Building America** is the program designed to bring “whole-buildings” thinking and technology to the residential construction market. The program acts as facilitator and catalyst in the formation of vertically integrated industry teams that use systems engineering approaches to evaluate the systems-level cost and performance of innovative design and delivery strategies, building materials and construction techniques. Building America public/private partnerships foster synergism and help focus all residential buildings R&D efforts on the most important technology needs and opportunities.

In commercial buildings the need for government participation is greatest in the retrofit market. Existing commercial buildings frequently undergo major renovations that offer prime opportunities to adopt a “whole-buildings” approach. To seize this opportunity, building owners and managers must be made aware of the technology and financing options available to enhance building energy performance, comfort and environmental soundness. To initiate a lasting transformation of retrofit practices, BTS has developed **Rebuild America**, a comprehensive energy-upgrade implementation program for existing commercial and multi-family buildings. Rebuild America partnerships bring together the variety of interests—owners, operators, financiers, and energy specialists—necessary to effect energy performance in our nation's commercial building stock.

With Building America and Rebuild America as capstone programs, the Building Systems program plays a pivotal role in implementing the *Buildings for the 21st Century* “whole-buildings” strategy. Although different in market focus, both programs integrate building component and systems R&D efforts, with deployment activities from all BTS programs. Building America and Rebuild America are flexible programs that build on the strengths of existing efforts at State and local levels to meet the unique priorities of local communities. Their strong market focus aligns all of the program's RD&D efforts with the needs of its customers.

### Planning Units

To implement its strategy and to deliver services to all target market segments and customers, the program groups its activities into two residential planning units: Residential Buildings R&D and Residential Technology Access; and two commercial planning units: Commercial Buildings R&D and Commercial Technology Access.

### Residential Buildings R&D

The Residential Buildings R&D planning unit includes three key activities: Building America, Energy Efficiency in Industrialized Housing, and Design Strategies. Building America embraces R&D using a whole-buildings approach to optimally integrate building

## **I. Mission Supporting Goals and Objectives: BUILDING SYSTEMS DESIGN (Cont'd)**

components, manufactured sub-assemblies and equipment, and renewable energy into new homes which consume 50% less energy than typical homes built in 1990. The Building America Industry teams will provide the leadership necessary to achieve the goal of transferring major systems innovations to 15,000 new homes within five years and to 70% of all new homes within ten years. The program is designed to provide feedback to improve R&D efforts and, through direct testing and evaluation of the costs and benefits associated with new building technologies, provides critical input to the development of formal building codes and appliance standards. Feedback from Building America and other R&D activities supports code revisions and voluntary initiatives by documenting levels of excellence that may benefit many homeowners.

The importance of the factory-built home segment is growing—accounting for 8% of the current building inventory and for 30% of new home construction—offering a unique opportunity for large energy savings at minimal cost. The Energy Efficient Industrialized Housing (EEIH) program seeks to apply the large advantages of factory fabrication (quality control, automation, etc.) to the construction of energy-efficient housing. Working with the industrialized housing industry and builders, the program considers technology innovations needed in manufacturing processes—at the factory—and in construction site assembly techniques for large-scale components. Manufactured homes and large building components developed and demonstrated by the EEIH program improve indoor air quality and support the international competitiveness of U.S. manufacturers of these products.

The Design Strategies program performs research on the fundamental relationships of energy performance and develops and maintains computer design and analysis tools. These tools are used by design professionals to evaluate options for equipment and materials selection, test solar design concepts, and study alternative design strategies to minimize whole-buildings energy use. Tools and analytical methods developed by the program assist in the development of industry consensus standards and guidelines. All residential programs use the tools and analytical methods to pre-test new technology strategies.

### **Residential Technology Access**

Technological innovations developed by Residential R&D programs are shared with the larger buildings community by means of three Residential Technology Access activities: Residential Energy Efficiency, Affordable Housing, and Home Energy Rating Systems. The Residential Energy Efficiency program consists of the activities required to incorporate the results of all R&D efforts into the knowledge base and standard practice of building professionals and homeowners, for both new construction and retrofit applications. Elements of the program are: information dissemination, education and training; technical and design assistance; on-site assistance; technology introduction and non-cash incentives (awards and recognition activities). Affordable Housing deployment activities involve working with local communities, HUD, public housing authorities and other community housing providers, to lower the utility costs of low- and moderate-income families. Home Energy Rating Systems help states overcome barriers to energy efficient financing by providing the technical support necessary to rate homes and identify energy efficiency improvement opportunities.

### **Commercial Buildings R&D**

The Commercial Buildings R&D planning unit includes two key activities: Building Performance and Design Strategies. Consistent with a whole-buildings approach, the Building Performance program focuses on developing the analytical bases necessary to

## I. Mission Supporting Goals and Objectives: BUILDING SYSTEMS DESIGN (Cont'd)

effectively design, operate and maintain buildings that are energy efficient, comfortable and conducive to health throughout their operational lifetime. The Design Strategies program develops the specific computer software tools required to make informed decisions on efficiency and renewable technology design strategies. These tools allow designers to simulate building performance and conduct “what-if” and trade-off analyses. Both programs contribute to the industry consensus process for standards and guidelines.

To ensure that the commercial buildings research agenda is responsive to the needs of industry, industry-developed R&D initiatives are reviewed to avoid duplication and to identify opportunities for cooperation. DOE participation with the Heating, Ventilating, Air-Conditioning and Refrigeration (HVAC&R) industry in the “*HVAC&R Research for the 21<sup>st</sup> Century*” program initiated by the Air-Conditioning and Refrigeration Institute is one example of the Department’s commitment to cost-shared research partnerships with industry. Research findings are transferred through FEMP and other Federal programs, State and local programs, and Rebuild America.

### Commercial Technology Access

Rebuild America spearheads the Department’s deployment and outreach efforts in commercial buildings and multifamily homes. The program helps the formation of community and regional public/private consortia that plan and implement energy efficiency retrofits in existing buildings. Rebuild America partners are provided a broad range of services including, information, training, and seed financial assistance to plan and finance retrofit projects. Rebuild America integrates the results of research and development initiatives within the Building Systems and the Building Equipment and Materials programs, and in return, provides the customer feedback needed to ensure the relevance of ongoing R&D activities.

The Commercial Outreach program focuses attention on building design, construction, and facility management professionals through the formation of outreach partnerships. The Energy Star building performance label is being promoted in collaboration with the EPA. Building operation and maintenance management training curriculum is being developed in partnership with facilities management organizations. Other outreach activities aim to disseminate industry design standards and guidelines often developed from the scientific basis provided by DOE R&D programs.

### I.B. Program Benefits

At the proposed funding levels, the Building Systems program is estimated to yield the following benefits:

METRIC	2000	2010	2020
Primary Energy Displaced (Quads)	0.02	0.46	.99
Energy Cost Savings (\$B)	0.14	2.86	5.93
Carbon Reductions (MMTons)	0.45	9.30	20.00

I. **Mission Supporting Goals and Objectives:** BUILDING SYSTEMS DESIGN (Cont'd)

I.C. Performance Goals

Strategy/Goals for 2000

With the residential buildings sector the program will create industry consortia in partnership with communities and financial institutions to develop advanced building systems, and deploy innovative technologies to lead a national effort to reduce energy usage in new homes by over 50% and existing home by 20%. The primary focus of the initiative is to increase the nation's capability to design, build and retrofit residential buildings that will increasingly be energy efficient and affordable. In addition the program will create local and community partnerships to retrofit one million public and assisted housing units.

For the commercial sector, the program will create consortia that will aid in the retrofitting of thousands of commercial buildings in communities around the nation. Advanced technologies developed and demonstrated under the program, including building diagnostics, will reduce the energy use in new buildings by 30% when compared to 1990 baseline buildings. In addition the commercial building program will achieve substantial change in the number of new buildings designed with full consideration of energy and the provided indoor environment through a comprehensive program of design tools development and deployment. It is estimated that less than 20% of submitted designs today include an analyses of energy options. By 2000, the Building Systems program will make energy and environmental analysis an integral part of 50% of the submitted designs in the country.

Accomplishment Summary

FY 1997

- The first community scale project of 330 houses under Building America was begun. Thirty-two (32) houses were built to 50% above local code, with savings in initial construction costs as well as long-term utility bills. In addition, Building America teams built an additional 78 tests and prototype houses in other states.
- Award new community housing partnerships were established to retrofit 100,000 public and assisted housing units.
- Ten new Rebuild America consortia committed to retrofitting 400 million square feet of floor space.
- "Passive Solar Design Strategies for Low Rise Buildings" was released. This major publication was widely distributed to the architectural community and included the latest DOE developed software tool ENERGY-10.
- Builder training programs were piloted in four states.

I. **Mission Supporting Goals and Objectives:** BUILDING SYSTEMS DESIGN (Cont'd)

FY 1998

- Second and third community scale projects of 200 houses under Building America program are under construction. Total of 300 demonstration houses will have been completed.
- Solicitation for new Energy Efficiency in Industrialized Housing (EEIH) contract will be awarded in FY99.
- Major new energy simulation program combining best features and capabilities of existing DOE and DOD energy tools will be released.
- Draft industry consensus standard on residential ventilation will be issued.
- Builder training programs in additional four states will be undertaken.
- HERS activities will continue in 7 states as well as national activities.
- Recruiting 55 new Rebuild America partnerships to join the program, increasing the total number of Rebuild America communities to 195 representing all 56 states and territories.

FY 1999 - 2000

- By FY 1999, five additional community scale projects with a total of 1000 houses will be under construction.
- New EEIH contract and begin revamped research.
- The commercial buildings program will establish that 50% of all designs submitted in the U.S. include analysis of energy and indoor environment.
- Two billion square feet of commercial building floor space will be addressed by the Rebuild America program resulting in 100 trillion Btu/year savings.
- By FY 2000, the Building America program will have developed 2500 highly energy efficient, environmentally friendly and cost effective houses and disseminated these results to 15,000 houses constructed by other builders.
- Recruit 85 new Rebuild America partnerships to join the program, increasing the total number of Rebuild America community to 280 exceeding original goal of 250 partnerships.

**II. A.     Funding Table: BUILDING SYSTEMS DESIGN**

Program Activity	FY 1997 Enacted	FY 1998 Enacted	FY 1999 Request	\$ Change	% Change
Residential Buildings . . . . .	\$ 10,157	\$ 9,697	\$ 15,292	\$ 5,595	58%
Commercial Buildings . . . . .	13,098	13,289	21,081	7,792	59%
Total, Building Systems Design . . . . .	<u>\$ 23,255</u>	<u>\$ 22,986</u>	<u>\$ 36,373</u>	<u>\$ 13,387</u>	<u>58%</u>

**II. B. Laboratory and Facility Funding Table: BUILDING SYSTEMS DESIGN**

Argonne National Lab (East) . . . . .	\$ 250	\$ 250	\$ 250	\$ 0	0%
Brookhaven National Lab . . . . .	100	100	100	0	0%
Lawrence Berkeley Lab . . . . .	3,400	3,200	5,985	2,785	87%
National Renewable Energy Lab . . . . .	7,200	6,993	12,383	5,390	77%
Oak Ridge National Lab . . . . .	3,230	3,175	4,570	1,395	44%
Pacific Northwest Lab . . . . .	1,930	1,875	1,835	-40	-2%
All Other . . . . .	7,145	7,393	11,250	3,857	52%
Total, Building Systems Design . . . . .	<u>\$ 23,255</u>	<u>\$ 22,986</u>	<u>\$ 36,373</u>	<u>\$ 13,387</u>	<u>58%</u>



### III. Performance Summary: BUILDING SYSTEMS DESIGN

Activity	FY 1997	FY 1998	FY 1999
Residential Buildings	<p>Residential Buildings R&amp;D includes:</p> <p>BUILDING AMERICA: The four primary Building America teams worked to: (a) accelerate the development and adoption of building processes and technical innovations in energy efficiency into environmentally sensitive, affordable housing on a community wide scale, (b) provide feedback to improve efforts for both research into new building technologies and methods to accelerate technology adoption based on field testing and performance validation.</p> <p>Building America continued the integration of research improving the performance of both new and existing housing. The program produced industrialized residential housing with large scale site assembled components, including panelized, modular, and HUD-Code manufactured units.</p>	<p>Residential Buildings R&amp;D includes:</p> <p>BUILDING AMERICA: The Building America program continues the integration of research that improves the performance of both new and existing housing. Over 80 industry members of Building America Consortia work in 12 States.</p>	<p>Residential Buildings R&amp;D includes:</p> <p>BUILDING AMERICA: Building America will expand to include 100 industry members. Over the next four years the program will indirectly transfer systems innovation to over 150,000 production homes, will adapt systems engineering to existing homes renovation, and will achieve direct consumer savings of \$115,000,000 per year. It is projected that by the year 2000, the Building America program will have directly developed 2,500 highly energy efficient, environmentally friendly, and cost-effective houses. At the same time, information will continue to be shared with the overall building industry; innovations used by Building America's team builders are expected to diffuse to all lead builders within 7-10 years. Systems integration research recommendations from the public, private Partnership for Advancing Technology in Housing (PATH) will be considered and incorporated into</p>

### III. Performance Summary: BUILDING SYSTEMS DESIGN (Cont'd)

Activity	FY 1997	FY 1998	FY 1999
Residential Buildings (Cont'd)	<p>Each team monitored test houses and prototype production houses, with major homebuilders, 32 of which have been built to 50% above local code, with savings in initial construction costs as well as long-term utility bills. Each began developing "first-generation" communities. As the Building America Industry Consortia teams moved from evaluation of individual test houses to community-scale construction. Construction of first community scale project of 330 houses began. Short term testing was complimented by long term data collection and utility bill analysis.</p> <p>An additional Building America project focused on buildings using passive solar/energy efficiency measures to meet 75 percent of their heating and cooling requirements at no additional construction cost to the owner. Working with various</p>	<p>Continue the emphasis on taking "lessons learned" from test houses and prototype production houses, working with major homebuilders and with additional builder members to develop two new "first-generation" communities of 200 houses. Complete a total of 300 demonstration houses.</p> <p>Research activities also focus on a thorough analysis of performance data on completed buildings built to passive solar standards. The information collected is used (1) to enhance passive solar design; (2) to re-engineer the concepts and adaptation to multiple</p>	<p>Building America to further efficiency and affordability.</p> <p>The program will continue the learning process from test and prototype production houses, expanding upon the existing developments and starting five new "first generation" communities of 200 homes each. Critical "next generation" strategic planning and systems integration research will continue as construction begins on several "second generation" test homes to validate advancements, and to incorporate them into new home and renovation practices. Continue efforts to improve thermal distribution using validation, demonstration and training to define quantitatively the benefits of efficient distribution systems.</p> <p>The program will also continue to focus on improving and simplifying advanced concepts used in the passive solar design houses constructed, at the owners expense, and monitored in FY 1997 and FY 1998. Replication of these lessons learned will begin</p>

### III. Performance Summary: BUILDING SYSTEMS DESIGN (Cont'd)

Activity	FY 1997	FY 1998	FY 1999
Residential Buildings (Cont'd)	<p>design/build teams, four completed homes were monitored. Data was partially analyzed. Work began on the redesign of selected concepts used in these buildings to improve performance, and adapting one design to a subdivision-scale development, creating a building using renewable energy strategies to meet all its energy needs. The Integrated Building and Construction Solutions of Pittsburgh, the Building Science Consortium, the Consortium for Advanced Residential Buildings and the Hickory Consortium; National Renewable Energy Laboratory [NREL], the Passive Solar Industries Council [PSIC] and the Florida Solar Energy Center) (\$4,562)</p> <p>ENERGY EFFICIENCY IN INDUSTRIALIZED HOUSING: Began working with Palm Harbor homes, a leading manufactured housing provider, to design and monitor the first manufactured houses to achieve Energy Star certification; began development</p>	<p>subdivision/planned unit developments, and (3) for additional passive and hybrid solar cooling concepts. Knowledge gained from these advanced buildings are used to enhance the capabilities of the "Passive Solar Design Strategy Guidelines and Design Tool," and analysis software. (the Integrated Building and Construction Solutions of Pittsburgh, Building Science Consortium, Consortium for Advanced Residential Buildings and the Hickory Consortium; NREL, PSIC and the Florida Solar Energy Center. (\$4,662)</p> <p>ENERGY EFFICIENCY IN INDUSTRIALIZED HOUSING: Continuing monitoring the two Energy Star Palm Harbor homes and the three entry level houses constructed in FY 1997; working with additional Manufactured Housing manufacturers;</p>	<p>to be performed in additional subdivision/planned unit developments, providing the opportunity to test needed passive cooling concepts and more effective means to integrate the auxiliary heating and cooling systems and other renewable energy technologies with the passive solar ones. Validation of the design and analysis tools used for these buildings will occur. In an effort to push performance levels higher, a major expansion of the Building America program will focus on the next generation of systems integration research, e.g., "zero energy home", incorporating emerging technologies and design techniques. This will provide information and experience to support Building America into the future. (\$8,762)</p> <p>ENERGY EFFICIENCY IN INDUSTRIALIZED HOUSING: Dissemination of research completed in FY98 will be made. The new competitive award will address the demand for affordable housing. This research will focus on the process of producing</p>

### III. Performance Summary: BUILDING SYSTEMS DESIGN (Cont'd)

Activity	FY 1997	FY 1998	FY 1999
Residential Buildings (Cont'd)	<p>of three side-by-side entry (first-time buyer) level houses with various levels of energy efficiency and IAQ features; partnered with the Structural Insulated Panel Association (SIPA) to develop a pair of houses in the state of Washington in cooperation with the American Engineered Wood Association (APA) and Habitat for Humanity International; assisted in field testing software to simulate factory site options in the production of wall panels; and completed evaluation of a innovative new floor system. Continued cooperative research with the American Lung Association and Habitat for Humanity for the construction and monitoring of four prototype houses, including the construction and monitoring of modular and industrialized housing. Monitored the performance of the four 1996 Health Houses. (Florida Solar Energy Center [FSEC], Lawrence Berkeley National Laboratory [LBNL], Penn State University [PSU], Oak Ridge National laboratory [ORNL], the</p>	<p>partnering with the Structural Insulated Panel Association (SIPA); American Engineered Wood Association (APA); and Habitat to develop a pair of houses in Plains, Georgia; assisting the American Lung Association in developing an entry-level "Health House" (TM); monitoring the performance of the FY 1997 Health Houses; continuing design assistance, workshops and seminars to individual Habitat affiliates and other non-profit housing providers; and field testing of the FSEC invented FanRecycler, that economically maintains indoor air quality (IAQ), in cooperation with the Building America Industry Consortia. Emphasis is on developing energy efficient and resource efficient housing, meeting the needs of local communities. As the current research winds down, a Request for Proposals is being issued to obtain new research resources for continuation of technologies developed by the program. Award of this competitive solicitation to be made in FY99.</p>	<p>energy efficient industrialized housing and large-scale site assemblage of components. Attention is on panelized, modular and HUD Code manufactured units. Partner determination for new research will be made during the RFP evaluation and award. A prototype manufacturing facility computer simulation model will be used to demonstrate adaptability of production facilities and assist in the continuing effort to improve the energy efficiency of the construction processes in two manufacturing housing plants. During FY 1999 producers of industrialized housing will continue working with Building America Consortia teams to develop new techniques for "whole house" factory production and site assemblage. Further, cooperative research will continue with the American Lung Association for the construction, monitoring and evaluation of Health Houses. (\$1,800)</p>

### III. Performance Summary: BUILDING SYSTEMS DESIGN (Cont'd)

Activity	FY 1997	FY 1998	FY 1999
Residential Buildings (Cont'd)	<p>University of Oregon [UO]) (\$1,500)</p> <p>DESIGN STRATEGIES: Contributed to the analysis and testing of residential ventilation standards, mathematical models duct measurement techniques and design tools as part of an industry consensus process (ASHRAE, ASTM, etc.). Worked with the International Alliance for Interoperability to ensure residential systems were incorporated into software standards; modified existing building computer models to analyze residential building design options. Four completed homes were monitored, data analyzed, and work began on redesigning of selected concepts used in these buildings to improve performance, to adapt one design to a subdivision-scale development, and on a building using renewable energy strategies to meet all its energy needs. (National Renewable Energy Laboratory [NREL], Lawrence Berkeley National Laboratory [LBNL], the University of Oregon [UO], and the Passive</p>	<p>(FSEC, LBNL, PSU, ORNL, UO) (\$1,300)</p> <p>DESIGN STRATEGIES: Research passive solar heating and cooling advanced concepts used in combination with efficiency and other renewable energy measures and system engineering, creating building designs that minimize building energy loads. Adapting and testing these concepts in multiple subdivision planned unit developments. Supporting industry consensus process with ASHRAE for thermal distribution and residential indoor air quality techniques. Releasing DOE-2.2 building analysis model with new residential HVAC system, natural ventilation and roof calculations. Adding residential HVAC and natural ventilation systems into a new simulation program under development, EnergyPlus. Finalizing Multi-zone infiltration model developed in cooperation with the International Energy Agency. Beginning fundamental study of the interactive effect of heat flow and mass flow in building envelopes. Continuing</p>	<p>DESIGN STRATEGIES: Develop test procedures and measurement techniques related to thermal distribution, air quality and air leakage with ASHRAE, and ASTM. Particular emphasis will be on technical contributions to the ASHRAE Standard for Residential Ventilation. Provide the prototypical next generation designs of low energy building concepts which the Building America consortia will incorporate. Replicate lessons learned into additional planned unit development, providing the opportunity to continue to test cooling concepts and more effective means to integrate the auxiliary systems with passive solar ones. Review and validate (as needed) design and analysis tools used for residential buildings. Incorporate new technologies, strategies and methodologies developed under the Building America and other projects into residential design tools as appropriate. Develop and modify version 2.0 of the</p>

### III. Performance Summary: BUILDING SYSTEMS DESIGN (Cont'd)

Activity	FY 1997	FY 1998	FY 1999
Residential Buildings (Cont'd)	<p>Solar Industries Council [PSIC]) (\$860)</p> <p>Technology Access includes: RESIDENTIAL ENERGY EFFICIENCY PROGRAM: Builders and building stakeholders in housing were trained in the integration of Building America technologies and building practices, and existing products and processes used to improve new and existing homes. Supported the Energy Value in Housing Awards in partnership with the National Association of Home Builders. Developed building guides, and energy efficient training specifications for builders. (National Association of Homebuilders Research Center [NAHBRC], Energy Efficient Builders Association [EEBA], Southface Energy Institute, National Association of Housing</p>	<p>work with the International Alliance for Interoperability to ensure residential energy issues are incorporated into building software standards. (NREL, LBNL, ORNL, UO, PSIC) (\$900)</p> <p>Technology Access includes: RESIDENTIAL ENERGY EFFICIENCY PROGRAM: Focus on the integration of advanced retrofit and whole building system technologies in existing residential buildings and new building design. Continuing training for builders, building trades and other stakeholders in housing, in the use of existing products and processes used to improve new and existing homes. Rewriting building design specifications, cost and energy saving estimates, operation and construction procedures for new and existing residential buildings, including low cost, affordable housing. (NAHBRC, EEBA, Southface Energy Institute, NAHRO) (\$700)</p>	<p>Building Design Advisor, and other residential building design tools. Insure the products being developed by the International Alliance of Interoperability with respect to residential energy issues, are coordinated in order to guarantee these concerns are addressed appropriately. (\$1,830)</p> <p>Technology Access includes: RESIDENTIAL ENERGY EFFICIENCY PROGRAM: Builders and building related stakeholders will be trained in the latest Building America technologies and building practices, how to overcome financial and technology barriers, and practices to improve new and existing homes. The trainees will be able to use a comprehensive design and renovation approach based on Building America techniques and technologies research to obtain an average of 20 percent energy efficiency gains in existing housing, while continuing to improve and expand the choices available for residential energy efficient and renewable technologies. (\$1,000)</p>

### III. Performance Summary: BUILDING SYSTEMS DESIGN (Cont'd)

Activity	FY 1997	FY 1998	FY 1999
Residential Buildings (Cont'd)	<p>Redevelopment Officials [NAHRO]) (\$700)</p> <p>AFFORDABLE HOUSING: Provided technical and design assistance to local communities, housing and financial industries, and to nonprofit community development organizations, Habitat for Humanity, National Association of Housing and Redevelopment Officials, The National Partnership for Homeownership, and others. Demonstrated and validated benefits of technologies in the design of new homes and retrofit of existing homes, integrating housing technologies that improved performance and were cost effective into standard practice. Developed housing and design guides for Military housing. (Oak Ridge National Laboratory [ORNL], Argonne National Laboratory [ANL], Southface Energy Institute, EEBA, Florida Solar Energy Center [FSEC], Habitat for Humanity [HFH], NAHRO) (\$1,000)</p>	<p>AFFORDABLE HOUSING: Providing training materials to Habitat for Humanity and assist other affordable housing organizations in developing energy efficient low cost housing. Working with the National Association Home Builders Research Center, National Center for Appropriate Technology and the Southface Energy Institute to develop training programs for builders and local contractors. Sponsoring over a dozen regional training seminars. Assisting twenty communities to develop energy efficient and/or sustainable development housing practices. Continuing a strong emphasis on approaches that aid home owners and prospective home buyers to recognize and value energy efficiency features. Providing training and education and showcased housing in partnership with local communities, housing and financial industries. Conducting small competitive solicitations for regional liaison support to local</p>	<p>AFFORDABLE HOUSING: Through training and on-site technical assistance improve the performance and cost effectiveness of affordable housing. Provide a coordinated and extensive education and training program in partnership with local communities, state agencies, and national associations to the housing and financial industries, nonprofit community development organizations, including Habitat for Humanity and others that will establish energy efficient housing features as standard practice. This will be done through a competitive solicitation. Target home providers that provide housing for low income families below the 80 percent of an area's median income, and that are supported through public housing. Sponsor more than two dozen residential build/design training program in partnership with local communities. (\$1,400)</p>

### III. Performance Summary: BUILDING SYSTEMS DESIGN (Cont'd)

Activity	FY 1997	FY 1998	FY 1999
Residential Buildings (Cont'd)	<p>HOME ENERGY RATING SYSTEMS: Provided funding to seven pilot states to overcome barriers to energy efficiency financing through the use of Home Energy Ratings, training and technical and information assistance. (\$1,535)</p>	<p>community housing agencies. (ORNL, ANL, FSEC, HFH, National Congress for Community Economic Development, Global Green USA, Southface Energy Institute, NAHRO) (\$600)</p> <p>HOME ENERGY RATING SYSTEMS: Continuing the fourth year of funding for seven pilot states. Providing support to other competitively selected states to overcome barriers to energy efficiency financing through Home Energy Ratings and related activities. (\$1,535)</p>	<p>HOME ENERGY RATING SYSTEMS: Half the funds are for the fifth and final year of financial support for the seven pilot states. The remainder is for other states, selected competitively, to overcome barriers to energy efficiency financing through Home Energy Ratings and related activities. (\$500)</p>
	\$10,157	\$9,697	\$ 15,292
Commercial Buildings	<p>Commercial Buildings R&amp;D includes: BUILDING PERFORMANCE (includes Commercial/ Multi-family R&amp;D): Conducted research on whole building concepts in buildings to quantify energy performance, and related non-energy performance (e.g. worker productivity). In FY97</p>	<p>Commercial Buildings R&amp;D includes: BUILDING PERFORMANCE (includes Commercial/ Multi-family R&amp;D): Conducting research on whole building concepts in buildings to quantify energy performance, and related non-energy performance. Completing performance</p>	<p>Commercial Buildings R&amp;D includes: BUILDING PERFORMANCE (includes Commercial/ Multi-family R&amp;D): Award the Request for Proposal begun in FY98 and increase research on whole building concepts in buildings to quantify energy performance, and related</p>



### III. Performance Summary: BUILDING SYSTEMS DESIGN (Cont'd)

Activity	FY 1997	FY 1998	FY 1999
Commercial Buildings (Cont'd)	<p>focused on advanced perimeter daylighting systems and their integration in buildings, and performance measurement of exemplary buildings constructed in FY 1995 and FY 1996. Continued testing of Building Automation Communication Network (BACNET), the communication protocol that will allow building owners to integrate control systems from multiple vendors, and testing the advanced lighting control system in the 450 Golden Gate building in San Francisco with GSA, and PG&amp;E. Continued work with National Science Foundation at Carnegie Mellon University to develop the "Intelligent Workplace." Started a national strategy for incorporating commissioning as a vital component of the industry construction process, with Federal Agencies and a collection of private organizations. This tool will verify building systems operate as the designer intended and provides the systems tests during commissioning to ensure maximum performance. A beta-test version of a tool which provides early detection of</p>	<p>measurement of exemplary buildings constructed in FY 1995 and FY 1996 and publish findings on the effectiveness of the integrated systems. Continuing testing of BACNET, and advanced lighting control system with GSA and PG&amp;E to demonstrate the effectiveness of an open communication protocol to connect equipment of various manufacturers. Continuing work with National Science Foundation at Carnegie Mellon University to develop the "Intelligent Workplace." Beginning whole building design study on school building with Southern California Edison (SCE). Completing the national strategy for incorporating commissioning as a vital component of the industry construction process which is promoted by Federal Agencies and a collection of private organizations. A commissioning planning guide for Rebuild America is being completed and distributed. An energy benchmarking tool, pivotal to early determination of potential candidates for efficiency renovation, is being expanded to</p>	<p>non-energy performance. With industry teams of manufacturers, designers and builders, work to improve and accelerate research and adoption of building processes and technical innovations that increase efficiency and affordability. Conduct monitoring and analysis activities at two exemplary passive solar buildings. Complete Carnegie Mellon University's "Intelligent Workplace" allowing performance testing of commercial systems integration, and complete and publish findings from the lighting/controls systems integration study on the 450 Golden Gate building in San Francisco. Continue commissioning and performance monitoring of school building with SCE. With industry, begin implementing actions defined in the national strategy for incorporating commissioning as a vital component of the industry construction process. Complete commissioning equipment/system performance technical specifications. The energy</p>

### III. Performance Summary: BUILDING SYSTEMS DESIGN (Cont'd)

Activity	FY 1997	FY 1998	FY 1999
Commercial Buildings (Cont'd)	<p>problems in building energy systems was completed in partnership with Honeywell and the University of Colorado (UC). An energy benchmarking tool, which is pivotal to early determination of potential candidates for efficiency renovation was completed for office buildings. In cooperation with the National Institute of Occupational Safety and Health (NIOSH), began fundamental studies of the relationship between indoor environments and worker productivity. (PNNL, UC, Honeywell, NSF) (\$2,000)</p> <p>DESIGN STRATEGIES: Developed energy design tools for the building industry to</p>	<p>include additional building types. Completing the final version of a tool which provides early detection of problems in building energy systems in partnership with Honeywell and the University of Colorado. Holding industry workshops to determine new directions for DOE's involvement in the controls, energy service, and other critical industries. This new roadmap for the Buildings Performance R&amp;D will be the basis for a competitive solicitation in FY99, developed and advertised in FY98. Fundamental productivity studies with NIOSH are producing first synthesis of results. Scientifically valid and statistically significant inferences regarding the effects of filtration are being reported to the building community. Contributing to the international efforts to develop scientifically valid basis for energy monitoring and verification protocols. (PNNL, LBNL, UC, Honeywell, NSF) (\$2,000)</p> <p>DESIGN STRATEGIES: Continuing the development of energy design tools for the</p>	<p>benchmarking tool, will be distributed widely for use by architects and engineers. In partnership with industry, develop materials which promote the wide spread use of the early problem detection tool developed with Honeywell and the University of Colorado. Establish database of project performance data that documents commercial building retrofits, including energy use, financing used, and measurement and verification methods. Fundamental studies with NIOSH will report on a second hypothesis on ventilation rates. Further hypotheses will be developed in cooperation with industry and academia. Efforts on Energy Monitoring and Verification protocols will shift to the implementation and promotion stage. (\$4,000)</p> <p>DESIGN STRATEGIES: Release the first version of EnergyPlus, a joint effort with</p>

### III. Performance Summary: BUILDING SYSTEMS DESIGN (Cont'd)

Activity	FY 1997	FY 1998	FY 1999
Commercial Buildings (Cont'd)	<p>predict performance implications of whole building design strategies and to answer "what if" questions. Tools allow designers to make tradeoffs early in the design, when critical decisions impacting energy use are made. Continued development of an object-based simulator for modelling advanced technologies. Completed development of DOE-2.2 (building energy simulation tool) for release in FY 1998. Completed final version of Softdesk Energy for release in early FY 1998. Released beta version of the Building Design Advisor. Worked with the Industry Alliance for Interoperability (IAI) to release the first two versions of the building software interoperability standards. Formed partnership with DOD (U.S. Army Corps of Engineers Construction Engineering Research Laboratories [CERL]) to develop EnergyPlus, an energy simulation program to replace DOE-2 and the DOD program, BLAST. Released version 1.2 of the Designing Low Energy Building/ENERGY-10 software</p>	<p>building industry to predict performance implications of whole building design strategies. Releasing DOE-2.2, final release of the DOE-2 program. Completing development of object-based simulator for beta testing. Completing beta testing of the Building Design Advisor (working with utilities and the California Institute for Energy Efficiency [CIEE]) and releasing version 1.0. Working with the Industry Alliance for Interoperability, releasing the third version (2.0) of the building software interoperability standards. Continuing development of EnergyPlus. With the international community and industry, developing modules for Designing Low Energy Buildings/ENERGY-10 software allowing trade-offs among passive and active solar, photovoltaic and efficiency strategies that may compete for the limited building surface while work proceeds on Version 2.0 to incorporate more complex and advanced passive solar, whole building concepts. Releasing a new version of the BESTEST,</p>	<p>DOD, combining strengths and capabilities of DOE-2 with DOD's BLAST (energy analysis software). Continue development of software module to simulate performance of complex innovative building systems that will then be integrated into EnergyPlus. Continue development of Building Design Advisor to integrate energy considerations into the early design phase for large commercial buildings. Release Version 2.0 of the Designing Low Energy Buildings/ENERGY-10 software package for making informed decisions among solar and efficiency strategies in small commercial and residential buildings in pre-design when critical decisions affecting energy use are made. Begin Version 3.0, incorporating advanced concepts learned in the buildings studies, customized weather data, and improved passive solar calculations. Continue participation in the Industry Alliance for Interoperability to ensure that energy attributes are part of international standards for sharing information among</p>

### III. Performance Summary: BUILDING SYSTEMS DESIGN (Cont'd)

Activity	FY 1997	FY 1998	FY 1999
Commercial Buildings (Cont'd)	<p>package, providing additional daylighting and efficiency strategies, and the ability to downsize mechanical systems developed with industry. Started work with the international community on procedures for evaluating design tools. Continued to contribute to the scientific basis of commercial ventilation standards and duct measurement techniques, industry standards and guidelines that relate to energy conserving designs of commercial buildings being developed by ASHRAE, ASTM, ISO and other groups. The result is timely and effective adoption of DOE supported technologies. (NREL, LBNL, PNNL, CERL, Univ. of IL) (\$3,200)</p> <p>Technology Access includes: REBUILD AMERICA: The Rebuild America program focuses on providing community partnerships with information needed to make informed decisions when they are renovating existing commercial and multifamily buildings. The partnerships focus on</p>	<p>software evaluation procedure. Continuing development of test procedures for duct distribution systems with industry through ASHRAE. (NREL, LBNL, CERL, Univ. of IL) (\$3,200)</p> <p>Technology access includes: REBUILD AMERICA: Rebuild America continues to help communities reduce energy costs in commercial and multifamily buildings. Increase partnership development and support to reach goal of 100 trillion Btu/yr saved by 2003. Two billion dollars will be saved in avoided energy bills</p>	<p>building-related software. Incorporate ventilation and mitigation strategies from our research to improve indoor air quality in EnergyPlus and Energy-10. Complete development of test procedures for duct distribution systems with industry through ASHRAE. (\$5,020)</p> <p>Technology Access includes: REBUILD AMERICA:</p>

### III. Performance Summary: BUILDING SYSTEMS DESIGN (Cont'd)

Activity	FY 1997	FY 1998	FY 1999
Commercial Buildings (Cont'd)	<p>comprehensive energy projects, including energy efficiency retrofits to lighting/heating/cooling systems and strategies for procurement of the most cost effective gas and electricity purchases. Information products, case studies and technical assistance are provided to local decision makers to identify energy opportunities, and to design and finance building energy projects. Technology transfer activities focus on outreach to building design, construction, and facility management professionals. The program provides a two way street for research in Buildings Systems; an outreach program to ensure research results make it into practice, and a comprehensive evaluation that provides feedback on the effectiveness of current R&amp;D programs and products based on actual needs identified in practice.</p> <p>Formed 50 new partnerships in FY 1997 -- a total of 140 partnerships in over 40 states. Partnerships started over \$1 billion dollars in energy</p>	<p>between FY 1995 - FY 2003 for commercial building owners and multifamily housing tenants because of building retrofits completed through the Rebuild America community partnerships. These energy retrofits will yield savings that continue into the next century at a rate of \$650 million/year. By the end of FY 1998, Rebuild America will be reducing energy costs and creating jobs in every state and territory in the nation. Maintain alliances with same organizations as FY 1997. Consortium is helping recruit and provide outreach for those communities developing and implementing Action Plans.</p> <p>Fifty-five new partnerships are being recruited to join the program, increasing the total Rebuild America communities to 195, representing all 56 states and</p>	<p>Recruit 85 additional partnerships to exceed the initial goal of 250. Continue two tiered strategy: 1) provide information and assistance to help locally led</p>

### III. Performance Summary: BUILDING SYSTEMS DESIGN (Cont'd)

Activity	FY 1997	FY 1998	FY 1999
Commercial Buildings (Cont'd)	<p>efficiency renovations in 500 million square feet of floorspace. Helping communities implement energy efficiency programs, alliances were established in FY 1995 and FY 1996 with U.S. Conference of Mayors, U.S. Chamber of Commerce, National Association of Counties, National Governors Association, Association of Higher Education Facility Officers, International City/County Management Association, National Association of Counties, and Public Technologies, Inc. (PTI)/Urban Consortium. The majority of new Rebuild America partnerships will receive only technical assistance and provide 100% of the funds to plan and carry out building energy improvements. Provided performance contracting assistance to lower utility costs for public and assisted housing. Leveraged more than \$27 million in contracts for private investments in energy related improvements for housing agencies. Established commitments for the energy rehabilitation of more than 100,000 affordable housing units.</p>	<p>territories. These Rebuild America partners are beginning to provide 100% of the funds to plan and carry out building energy improvements. New partners in FY 1998 are implementing Action Plans that will result in over 400 million square feet of floor space renovated, reducing annual costs by \$143 million when local actions are completed. FY 1998 partners are creating 5,720 jobs in the construction trades, and reducing emissions by 0.345 MMTCE reducing smog and global warming effects from fossil fueled power plants. Partners are leveraging \$40-\$50 million in performance contracts for public and assisted housing, with 200,000 units committed for rehabilitation. DOE technical assistance is meeting unique needs of partnerships, e.g., development of information handbooks on technology performance and financing strategies, access to hotlines and electronic bulletin boards, peer-to-peer workshops, training seminars, and customized expertise from DOE national laboratory staff. Continuing</p>	<p>partnerships retrofit buildings, and 2) continue successful alliances with national organizations, e.g., U.S. Conference of Mayors, Association of Higher Education Facility Officers, to reach national representatives of key local decision-makers. Continue and expand support of showcase community partnerships started in FY 1995 and FY 1996. These partnerships represent coalitions of diverse organizations and will reduce energy costs in schools, city/county/state buildings, small businesses, and corporations across the nation. In collaboration with DOE, partnerships will use innovative strategies to maximize market penetration and ensure that efforts continue after Federal funds are gone, e.g., institutionalizing the use of performance contracting, integration of energy improvements with the Department of Housing and Urban Development's Enterprise and Empowerment Zones, working within local chambers of commerce as part of local economic development strategy,</p>

### III. Performance Summary: BUILDING SYSTEMS DESIGN (Cont'd)

Activity	FY 1997	FY 1998	FY 1999
Commercial Buildings (Cont'd)	<p>Provided technical assistance to ninety five existing partnerships. Technical assistance is tailored to meet unique needs of partnerships, e.g., development of information handbooks on technology performance and financing strategies, access to hotlines and electronic bulletin boards, peer-to-peer workshops, training seminars, and customized expertise from DOE national laboratory staff. (LBNL, ORNL, PNNL, ANL, NREL) (\$6,850)</p>	<p>alliances with national organizations representing local government, public housing authorities, private business, universities, schools, utilities, energy service and financing companies to increase participation and leverage education and technical assistance to partners; recruiting and helping new partnerships develop action plans, providing planning workshops and training on technologies, financing, and the retrofit process; developing handbooks and guidelines to help partners and building owners understand energy efficient technologies and financing strategies; providing on-site assistance to partnerships with completed action plans; sponsoring conferences to promote spread of best practices among partners, developing WWW home pages, newsletters, technology briefs, and; promoting and recognizing partnership successful approaches and results. (LBNL, ORNL, PNNL, ANL, NREL, APPA, USCM) (\$7,000)</p>	<p>etc. Provide products and technical assistance tailored to meet unique needs of partnerships, e.g., development of information handbooks on technology performance and financing strategies, assistance in adopting whole building retrofits, access to hotlines and electronic bulletin boards, peer-to-peer workshops, training seminars, and customized expertise from DOE national laboratory staff and private sector experts. The program will increase awareness, adoption, and use of the "whole building" approach by industry and communities. (\$10,580)</p>

### III. Performance Summary: BUILDING SYSTEMS DESIGN (Cont'd)

Activity	FY 1997	FY 1998	FY 1999
Commercial Buildings (Cont'd)	<p>OUTREACH: In collaboration with the Environmental Protection Agency, began development of an Energy Star building performance label, a benchmark for energy efficient buildings, that will help establish value for energy efficient buildings in the commercial real estate market. Began project with International Union of Stationary Engineers (IUSE) to develop training for persons working directly with equipment operation. Continued promotion and support of the industry consensus guidelines related to energy conserving designs of commercial buildings developed with ASHRAE, ASTM, ISO and other groups. (IUSE) (\$1,048)</p>	<p>OUTREACH: In collaboration with the Environmental Protection Agency, the program is introducing and promoting the Energy Star building performance label, a benchmark for energy efficient commercial buildings, that will help establish value for energy efficient buildings in the commercial real estate market. Designing building operations and facility management training curriculums in partnership with the International Facilities Management Association, the Association of Higher Education Facilities Officers, and other organizations responsible for training building facility managers and building operators. This builds on previous successes working with the International Union of Stationary Engineers to develop training for persons working directly with equipment operation. Continuing design assistance service for large scale commercial construction projects to increase adoption of ENERGY STAR performance label for new construction in addition to promoting other Commercial R&amp;D products and experience.</p>	<p>OUTREACH: Continue collaboration with the Environmental Protection Agency to promote and test the Energy Star building performance label, a benchmark for energy efficient buildings, that will help increase value for energy efficient buildings in the commercial real estate market. With the Office of Codes and Standards, Building Standards and Guidelines activity, run pilot projects in partnership with States and utilities to test automatic energy code compliance strategies through the awarding of the Energy Star label. Using previously developed curricula, begin building operation/facility management training and train building facility managers in partnership with the International Facilities Management Association, the Association of Higher Education Facilities Officers, and other organizations responsible for training building facility managers and building operators. Continue design assistance service for large scale commercial construction projects to increase adoption of whole building design</p>



**III. Performance Summary: BUILDING SYSTEMS DESIGN (Cont'd)**

Activity	FY 1997	FY 1998	FY 1999
Commercial Buildings (Cont'd)		Disseminating, synthesizing, and otherwise promoting the use of industry standards and guidelines relating to energy conserving designs of commercial buildings being developed by ASHRAE, ASTM, ISO and other groups. (IUSE, APPA) (\$1,089)	approaches and tools, appropriate Commercial R&D products, including recognition of the ENERGY STAR performance label. Outreach activities will focus on building design, construction, and facility management professionals. Promote use of the International Measurement and Verification Protocol to provide building owners and financiers with a tool to evaluate and increase investment in energy efficiency. (\$1,481)
	\$13,098	\$13,289	\$21,081
Building Systems Design Total	\$ 23,255	\$ 22,986	\$ 36,373

BUILDING TECHNOLOGIES  
BUILDING TECHNOLOGY, STATE, AND COMMUNITY SECTOR  
(dollars in thousands)

BUILDING EQUIPMENT AND MATERIALS

I. **Mission Supporting Goals and Objectives:**

I.A. Statement of Mission

The mission of the Building Equipment and Materials program is to conduct research, development and deployment activities in cooperation with private industry to provide industry with the advanced technology base needed for highly-efficient, globally competitive building components (equipment, envelope subsystems and materials) and to accelerate the adoption and widespread utilization of these advanced components within both residential and commercial buildings.

Buildings are responsible for 36 percent of the nation's total energy use, including 66 percent of its electricity consumption. In addition to the \$220 billion of direct cost that this represents to consumers, building energy use contributes significantly to air and water pollution and depletion of the earth's non-renewable natural resources.

The long range goal of the Building Equipment and Materials program is to reduce sector energy consumption by 50% when the program's advanced technology has fully penetrated the market. The strategy to achieve these goals is to maintain a balance between (1) creating new technologies through cost-shared laboratory research and development projects and (2) accelerating the introduction of new technologies through technology partnerships using innovative approaches. It employs three major technology pathways: Space Conditioning Equipment; Lighting and Appliances R&D; and Building Envelope R&D.

Within residential buildings, advanced gas-fired heat pump technologies now being developed have the potential to double the efficiency of conventional equipment used for space heating and cooling, and for water heating. Similarly, new lighting technologies will use less than half the energy of today's standard incandescent lamps while lasting ten times as long. Advanced refrigeration research, coupled with new thermal insulating technologies, will greatly reduce the energy use of residential refrigerator/freezers, and new technologies will also convert residential windows from a significant energy burden into a net source of building energy through a combination of high thermal performance and selective capture of solar gain.

I. **Mission Supporting Goals and Objectives:** BUILDING EQUIPMENT AND MATERIALS (Cont'd)

Commercial buildings will also benefit from activities within the Building Equipment and Materials program. Advanced commercial chillers and small-scale fuel cells are two technologies under development that will improve commercial building energy performance while displacing electricity with natural gas during the summer peak demand periods. Scotopic lighting and advanced light distribution technologies hold promise to improve worker productivity in addition to reducing commercial building lighting energy consumption. Commercial buildings will also benefit from research and development of electrochromic windows that have the capability of varying optical and solar heat gain properties, high performance low-slope roofing systems, and the development of new coatings and materials that reduce urban heat island effects.

By the year 2000, the Building Equipment and Materials program will achieve the following:

- market introduction of more than 10 new advanced technology products,
- initial export shipments for 5 new products using DOE technology, and
- accelerated market introduction of 6 new and emerging products which are the most efficient in their product class.

I.B. Program Benefits

At the proposed funding levels, the Building Equipment and Materials Program is estimated to yield the following benefits:

METRIC	2000	2010	2020
Primary Energy Displaced (Quads)	0.02	0.60	2.12
Energy Cost Savings (\$B)	0.14	4.57	14.66
Carbon Reductions (MMTons)	0.41	15.04	50.81

I. **Mission Supporting Goals and Objectives:** BUILDING EQUIPMENT AND MATERIALS (Cont'd)

I.C. Performance Goals

Strategy/Goal for 2000

Space Conditioning R&D

In partnership with small business R&D firms, manufacturers, utilities and professional organizations, the Space Conditioning R&D planning unit will develop space heating, cooling and refrigeration technologies such as natural gas driven heat pumps and chillers and space cooling and refrigeration technologies using non-ozone depleting refrigerants, and accelerate market introduction through high volume purchases, utility program coordination, and technical information dissemination, resulting in 1 TBtu of energy saved in 2000.

Lighting and Appliance R&D

In partnership with small business R&D firms, manufacturers, utilities and professional organizations, the Lighting and Appliance R&D planning unit will develop advanced lighting and appliance technologies such as low-power sulfur lamps, more efficient lighting fixtures, the scotopic lighting concept, heat pump water heaters, high efficiency laundry equipment, refrigerators and commercial refrigeration equipment, and accelerate market introduction through demonstrations, volume purchases, utility program coordination, and technical information dissemination, resulting in 9 TBtu of energy saved in 2000.

Building Envelope R&D

The Thermal Insulation and Building Materials planning unit will establish an industry-acceptable single design for a low-slope roof having an R-30 insulating value and a 30-year useful life that is adopted as general practice within the building industry. The program also will complete development and demonstrate super-insulating materials that exhibit R-50 insulating value per inch, have a 20-year life, and are cost effective in building and appliance applications. Standards will be developed for measuring and labeling reflectivity on roofing and paving materials. This will enable customers to design high reflective surfaces, thus reducing cooling loads on buildings. These advances will result in 6 TBtu of energy saved in 2000.

The Windows and Glazing planning unit will, through industry partnerships, commercialize electrochromic windows for niche markets for architectural applications. Along with industry's investment in high performance window and glazing production capability, the program will double the market share of these products as compared to 1995, resulting in an energy savings of 1 TBtu in 2000.

I. **Mission Supporting Goals and Objectives:** BUILDING EQUIPMENT AND MATERIALS (Cont'd)

Accomplishment Summary

FY 1997

- Completed preliminary design of a low-powered sulfur lamp laboratory prototype using solid state power source; target efficiency is 100 lumens per watt, target life is 10-20 years.
- Completed laboratory research on the scotopic lighting concept.
- Demonstrated an R-50 per inch super-insulating powder vacuum insulation panel for use in both residential and commercial appliances such as refrigerators and freezers.
- Awarded phase II industry consortium pilot production of electrochromic window prototypes to develop expanded durability testing.
- Launched ENERGY STAR appliance program nationally in conjunction with manufacturers and utilities to promote appliances significantly exceeding present efficiency standards.
- Added clothes washers to the portfolio of ENERGY STAR products, qualifying models use 53% less energy than minimum efficiency standards.
- Expanded nationwide the public housing refrigerator purchasing partnerships with 71,000 newly-designed units with a 15% energy efficiency improvement over the best currently available technology.
- With manufacturers, demonstrated high efficiency washers for commercial and residential buildings that reduce energy consumption by over 55%.

FY 1998

- Complete test and evaluation of a full-scale laboratory prototype of a natural gas absorption chiller using DOE's advanced DCC

I. **Mission Supporting Goals and Objectives:** BUILDING EQUIPMENT AND MATERIALS (Cont'd)

technology at York International.

- Complete initial laboratory R&D to determine feasibility of prototype low-power sulfur lamp for residential applications.
- Develop standards for measuring and labeling reflectivity on roofing and paving products and develop a data base of materials available with high reflectivity coatings.
- Add windows to the ENERGY STAR portfolio; double the number of retail stores labelling ENERGY STAR appliances to 2,400 nationwide; recruit five major appliance manufacturers to label ENERGY STAR appliances at the factory; and increase sales of ENERGY STAR appliances by 30% over 1997.
- Establish "Total Equivalent Warming Index" as the analytical comparative basis for insulating foam blowing agents.
- Successful development and demonstration of the Whole Wall Rating System.
- Through the DOE's hotel/motel consortium, promote sales of 20 laundry hot wastewater recycling and reuse systems saving 300 million gallons of water and 2 billion Btu.
- Expand ENERGY STAR appliances in manufactured homes to include home builders throughout the U.S..

FY 1999 - 2000

- Complete field test of a commercial prototype DCC absorption chiller with York International.
- Begin testing a laboratory prototype version of a natural gas Hi-Cool heat pump using advanced absorption technology.
- Complete research and demonstrate a pre-production prototype refrigerator/freezer with an industry partner that uses 1 kWh/day of electricity, 50% less than current standards allow.
- Demonstrate energy efficient supermarket refrigeration and heat recovery systems in three new or remodeled supermarkets.

I. **Mission Supporting Goals and Objectives:** BUILDING EQUIPMENT AND MATERIALS (Cont'd)

- Initiate sales of small residential electric heat pump water heaters by a major manufacturer, with the objective of selling 100,000 units per year by 2005.
- Successfully demonstrate full-size electrochromic windows.
- Work with the Federal Trade Commission (FTC) to allow manufacturers to add the ENERGY STAR logo to the yellow and black FTC "energy guide" label for covered products, and recruit an additional 1,500 stores to label ENERGY STAR appliances nationwide.
- Issue major solicitation on sustainable insulation.
- Establish industry/government consensus rating system for building envelope components, i.e., walls and roofs.
- Successfully demonstrate full-size high performance spectrally selective windows utilizing enhanced ion-beam deposition.
- Industry/government Windows Collaboration will have significantly contributed to doubling of market share for highly efficient windows.

**II. A.     Funding Table: BUILDING EQUIPMENT AND MATERIALS**

Program Activity	FY 1997 Enacted	FY 1998 Enacted	FY 1999 Request	\$ Change	% Change
Technology Roadmaps and Competitive R&D . .	\$       0	\$       0	\$    8,000	\$    8,000	>999%
Space Conditioning and Cogeneration . . . . .	11,440	12,430	15,380	2,950	24%
Lighting and Appliance . . . . .	6,798	5,342	11,080	5,738	107%
Building Envelope R&D . . . . .	7,842	9,149	11,721	2,572	28%
Total, Building Equipment and Materials . . . . .	<u>\$  26,080</u>	<u>\$  26,921</u>	<u>\$  46,181</u>	<u>\$  19,260</u>	<u>72%</u>

**II. B. Laboratory and Facility Funding Table: BUILDING EQUIPMENT AND MATERIALS**

Argonne National Lab (East) . . . . .	\$     100	\$     200	\$     200	\$       0	0%
Brookhaven National Lab . . . . .	600	700	700	0	0%
Lawrence Berkeley Lab . . . . .	4,200	5,000	6,000	1,000	20%
National Renewable Energy Lab . . . . .	900	1,100	1,100	0	0%
Oak Ridge National Lab . . . . .	12,000	13,000	15,100	2,100	16%
Pacific Northwest Lab . . . . .	3,800	2,000	5,600	3,600	180%
All Other . . . . .	4,480	4,921	17,481	12,560	255%
Total, Building Equipment and Materials . . .	<u>\$  26,080</u>	<u>\$  26,921</u>	<u>\$  46,181</u>	<u>\$  19,260</u>	<u>72%</u>



### III. Performance Summary: BUILDING EQUIPMENT AND MATERIALS

Activity	FY 1997	FY 1998	FY 1999
Technology Roadmaps and Competitive R&D			<p>This effort represents a new approach to conducting research for the building sector. Based upon the direction identified in the Office of Building Technology, State and Community Programs strategic plan, development of 3-5 technology "road maps" in collaboration with industry and the research community will continue. The technology road maps will be drawn from areas identified in the strategic plan including heating, cooling and ventilation; envelope technology; lighting, appliances, cogeneration and system integration. Participants will include industry leaders, academics, national laboratories, states, and other identified contributors to each road map. The goal is to identify and implement research and technology access actions necessary to develop and bring new energy efficient technologies that will save energy and money</p>

### III. Performance Summary: BUILDING EQUIPMENT AND MATERIALS (Cont'd)

Activity	FY 1997	FY 1998	FY 1999
Technology Roadmaps and Competitive R&D (Cont'd)			and have beneficial environmental impacts, to the marketplace. These metrics will be developed in concert with industry partners as the road maps are designed. Research and development actions, that are identified as appropriate for DOE, will be undertaken through competitive procurement and will be cost-shared with partners. (TBD) (\$8,000)
	\$ 0	\$ 0	\$ 8,000
Space Conditioning and Cogeneration	Heating and Cooling includes: RESIDENTIAL ABSORPTION HEAT PUMPS: The goal of this program is to develop two different gas-fired Absorption heat pump concepts: 1) first generation GAX heat pump for markets where heating dominates energy use and 2) a second generation "Hi-cool" Absorption heat pump with 30% higher cooling performance for cooling dominated markets. To	RESIDENTIAL ABSORPTION HEAT PUMPS: The goal of this program is to develop two different gas-fired Absorption heat pump concepts: 1) first generation GAX heat pump for markets where heating dominates energy use and 2) a second generation "Hi-cool" Absorption heat pump with 30% higher cooling performance for cooling dominated markets. In the period	RESIDENTIAL ABSORPTION HEAT PUMPS: The goal of this program is to develop two different gas-fired Absorption heat pump concepts: 1) first generation GAX heat pump for markets where heating dominates energy use and 2) a second generation "Hi-cool" Absorption heat pump with 30% higher cooling performance for cooling dominated markets. In the period

### III. Performance Summary: BUILDING EQUIPMENT AND MATERIALS (Cont'd)

Activity	FY 1997	FY 1998	FY 1999
Space Conditioning and Cogeneration (Cont'd)	<p>independent, industry supported evaluations judged the GAX technology superior in performance and cost to other cycles and is the preferred cycle for a commercial product in 2000+. The program strategy is to develop Hi-cool basic technology in parallel with developing the GAX, working with small business, R&amp;D firms, HVAC manufacturers and the gas industry. In the period 1997-2000, the GAX effort will focus on moving the technology from laboratory ASM to industry led field tests of complete heat pump units. The "Hi-cool" effort will focus on R&amp;D of ASM laboratory components and initial stages of system development. The ASM is a single unit that houses the major absorption components. In FY 1997, three first generation prototype GAX heat pumps were fabricated and testing began at a national laboratory. Increased manufacturing involvement with a</p>	<p>1997-2000, the GAX effort will focus on moving the ASM technology from the laboratory to industry led field tests of complete heat pump units. The "Hi-cool" effort will focus on R&amp;D of the ASM laboratory components and initial stages of system development for a complete heat pump with market potential in 2005. The ASM is a single unit that houses the major absorption components. In FY 1998, complete initial laboratory testing of a first generation GAX heat pump, and initiate testing at a gas industry selected site. Working with a small business manufacturer of absorption systems, establish the design and begin fabrication of pre-production prototype units for field testing. Work with a major HVAC manufacturer of heat exchangers to complete design and begin building multiple heat exchanger for residential field test units and laboratory heat pumps. Work</p>	<p>1997-2000, the GAX effort will focus on moving the ASM technology from the laboratory to industry led field tests of complete heat pump units. The "Hi-cool" effort will focus on R&amp;D of ASM laboratory components and initial stages of system development for a complete heat pump market potential in 2005. The ASM is a single unit that houses the major absorption. In FY 1999, complete test and evaluation of prototype GAX heat pump at a gas industry site. Work with a small business manufacturer of absorption units to build multiple prototype GAX heat pumps for a multiple field testing. With a major HVAC manufacturer of heat exchangers, design and build heat exchanger for small commercial laboratory heat pumps. With major gas utilities in an industry led consortium, continue to develop GAX prototypes, manufacturing processes, conduct field tests and</p>

### III. Performance Summary: BUILDING EQUIPMENT AND MATERIALS (Cont'd)

Activity	FY 1997	FY 1998	FY 1999
Space Conditioning and Cogeneration (Cont'd)	<p>small business absorption chiller manufacturer began to design and develop prototype heat pumps using GAX components. Working with a major HVAC manufacturer, developed heat exchanger design for the laboratory heat pumps. With small businesses, designed, fabricated and continued laboratory testing of critical components and high temperature materials research for two different design concepts, a branched GAX and an Solid/Vapor. (EPAct Section 2102) Phillips, Robur, Lennox, Energy Concepts, Rocky Research) (\$5,212)</p>	<p>with manufacturers and key gas utilities to form an industry-led consortium to develop GAX prototypes, manufacturing processes, and conduct field tests and market analysis. Initiate the scale-up design of the ASM for GAX technology from residential to small commercial size unit in response to market opportunity identified by the gas industry, and HVAC manufacturers. In FY-1998, continue test, evaluation, and increased manufacturers involvement leading to commercialization. In FY 1998 laboratory testing of critical components for two different design concepts: branched GAX and solid/vapor will be completed. Fabrication and testing of prototype heat pumps and of ASM units will begin. (EPAct Section 2102) (Phillips, Robur, Lennox, Energy Concepts, Rocky Research, ORNL) (\$5,400)</p>	<p>market analysis. Build critical components for the scale up design of the GAX ASM units for residential and small commercial market opportunities identified by the gas industry, and HVAC manufacturers. In FY 1999, with increased manufacturers involvement, complete a manufacturing cost analysis to verify first cost and marketability of a commercial product. In FY 1999, complete fabrication of an ASM for prototype small commercial Hi-cool branched GAX heat pump. Complete laboratory testing of high temperature heat exchanger for the Solid/Vapor heat pump concept. (Phillips, Robur, Lennox, Energy Concepts, Rocky Research, ORNL) (\$6,450)</p>

### III. Performance Summary: BUILDING EQUIPMENT AND MATERIALS (Cont'd)

Activity	FY 1997	FY 1998	FY 1999
Space Conditioning and Cogeneration (Cont'd)	<p>DESICCANTS AND CHILLERS: The goal of this activity is to develop natural gas-fired desiccants and chillers to reduce energy used for air conditioning, reduce electric peak loads and improve indoor air quality in commercial buildings. The FY-1997 objective is to field test and evaluate desiccant systems in comparative testing with standard HVAC cooling equipment and laboratory test advanced components. For the chiller, evaluate the performance of a high efficiency prototype commercial size chiller. Moisture and humidity problems in buildings result in significant excess energy consumption in conventional cooling equipment, in poor indoor air quality and in high costs for more frequent renovation (estimated to cost the hotel/motel industry alone \$70 million a year). The wet coils and ductwork in conventional cooling systems in humid areas breed</p>	<p>DESICCANTS AND CHILLERS: The goal of this activity is to develop natural gas-fired desiccants and chillers to reduce energy used for air conditioning, reduce electric peak loads and improve indoor air quality in commercial buildings. The FY-1998 objective is to continue field test and evaluation of additional desiccant systems for comparative testing with standard HVAC cooling equipment and initiate concept evaluation of liquid desiccant systems in laboratory testing. For the chiller, complete testing of a high performance commercial size chiller. Continue to develop two solid desiccant concepts in competitively-selected projects with cost-sharing industry partners. Expand the comparative field test of a desiccant air-conditioner concept to include large restaurants and schools. Begin a field pilot test of the desiccant pre-conditioner for</p>	<p>DESICCANTS AND CHILLERS: The goal of this activity is to develop natural gas-fired desiccants and chillers to reduce energy used for air conditioning, reduce electric peak loads and improve indoor air quality in commercial buildings. The FY-1999 objective is to begin testing of a prototype desiccant based pre-conditioner into a modular HVAC system. Complete field testing of desiccant systems in comparative testing with standard HVAC cooling equipment and laboratory test advanced components. For the chiller, begin field testing of a modified high efficiency pre-production commercial size chiller. Continue to develop two desiccant concepts in competitively-selected projects with cost-sharing industry partners. Monitor comparative field tests of a desiccant air-conditioner concept at large restaurants and schools and</p>

### III. Performance Summary: BUILDING EQUIPMENT AND MATERIALS (Cont'd)

Activity	FY 1997	FY 1998	FY 1999
Space Conditioning and Cogeneration (Cont'd)	<p>mold and bacteria which can be a health hazard. In addition, new ASHRAE requirements for greatly increased ventilation air to achieve good indoor air quality place an additional dehumidification burden on air conditioning systems. Desiccants have the ability to reduce moisture levels, improve air quality and treat increased ventilation air rates with lower energy consumption than conventional systems. Continued to develop two solid desiccant concepts in competitively-selected projects with cost-sharing industry partners: continued a comparative field test of a desiccant air-conditioner concept in small restaurants and theaters and developed a desiccant pre-conditioner for treating ventilation air in combination with conventional air-conditioning systems. Completed the initial round of</p>	<p>treating ventilation air in combination with conventional air-conditioning systems and initiate development of fully integrated combined unit. Continue to work with manufacturers in testing and evaluating prototype solid desiccant wheels. Begin initial tests of a new liquid desiccant absorber. Continue cost-shared development of a DCC absorption chiller at York International. Complete performance test of a full-scale laboratory prototype. Complete cost analysis and market study as a prelude to field test of a commercial prototype based on materials characterized in the dynamic corrosion studies. Complete development of the critical components for a commercial prototype unit for field test. (Semco/Trane, ICC Technologies, AIL, NREL, York International, ORNL) (\$2,400)</p>	<p>complete a report on IAQ benefits, costs and energy savings in the field installations. Complete a field pilot test of the desiccant pre-conditioner for treating ventilation air and complete development and initiate a field test of a unit with integrated desiccants and conventional air-conditioning. Complete the second round of testing of manufacturer prototype solid desiccant wheels. Expand liquid desiccant efforts by initiating industry cost-shared development of high efficiency liquid dehumidifiers. Continue cost-shared development of a DCC absorption chiller at York International. Perform a field test of a commercial prototype DCC chiller in cooperation with York International. A successful field test will complete the project. Evaluate opportunities for increasing performance and reducing emissions of gas engine-driven chillers, as an</p>

### III. Performance Summary: BUILDING EQUIPMENT AND MATERIALS (Cont'd)

Activity	FY 1997	FY 1998	FY 1999
Space Conditioning and Cogeneration (Cont'd)	prototype testing and established a figure-of-merit for rating solid desiccant wheels. Initiated exploratory studies of liquid desiccant systems. The goal for large chillers is to develop, for large commercial buildings, absorption chillers based on DOE-patents with 40% higher cooling efficiency than the best existing (Japanese) technology. The first of two key technologies has been licensed and is being independently developed by a major manufacturer with gas industry funding. The second, the Double-Condenser Coupled (DCC) concept, is being developed in a 35% cost-shared effort with competitively-selected York International and with technical support from small business R&D firms. Completed fabrication and began performance test of a full-scale laboratory prototype DCC chiller. Initiated corrosion studies in a new dynamic test facility to		alternative to absorption chillers. (Semco/Trane, ICC Technologies, AIL, NREL, York International, ORNL) (\$2,300)

### III. Performance Summary: BUILDING EQUIPMENT AND MATERIALS (Cont'd)

Activity	FY 1997	FY 1998	FY 1999
Space Conditioning and Cogeneration (Cont'd)	<p>identify low-cost materials. Continued development of the critical components for a commercial field test prototype. (Semco/Trane, ICC Technologies, AIL, NREL, York International, ORNL) (\$2,518)</p> <p>FURNACES AND BOILER/COMBUSTION RESEARCH: The 11 million U.S. homes and numerous commercial buildings relying on oil-fueled space heating and water heating equipment consume 2.1 quads of oil annually. The purpose of this program is to provide the R&amp;D for a U.S. oil heat equipment industry which has very limited R&amp;D capability and is susceptible to foreign competition. The primary goal is to develop combustion systems which do not degrade in efficiency and which are applicable to today's more efficient buildings. To meet this goal, research continues with</p>	<p>FURNACES AND BOILER/COMBUSTION RESEARCH: Continue research with small business manufacturers on several designs for a low firing rate fan atomized burner (FAB), exploiting unique advantages of this new burner, including: a low-cost design and a self-tuning design. Under continuing NYSERDA cost sharing of small business manufacturers, conduct field testing of the basic, low excess air FAB with furnace/boiler manufacturers. Terminate work on two stage prototype FAB in favor of designs offering higher potential. Also with NYSERDA cost-sharing, continue to develop</p>	<p>FURNACES AND BOILER/COMBUSTION RESEARCH: Continue research with small business manufacturers on several designs for a low firing rate fan atomized burner (FAB), exploiting unique advantages of this new burner, including: a low-cost design and a self-tuning design. Through a continuation of the NYSERDA CRADA with BNL, support a small business burner manufacturer in design and testing of pre production prototype version of the simplified fan atomized burner with potential for lower production cost. Continue development of self-tuning oil</p>



### III. Performance Summary: BUILDING EQUIPMENT AND MATERIALS (Cont'd)

Activity	FY 1997	FY 1998	FY 1999
Space Conditioning and Cogeneration (Cont'd)	<p>small business manufacturers on several designs for a low firing rate fan atomized burner (FAB), exploiting unique advantages of this new burner concept, including: a two-stage firing rate design, a low-cost design and a self-tuning design. Completed work on a basic, low excess air FAB under NYSERDA cost-sharing to obtain UL approval. Two-stage FAB: investigated optional controls. Low-cost design: Explored design options to simultaneously reduce burner head complexity and lower NOx emissions. Self-Tuning Burner: Initiated research in response to strong industry interest in an advanced system which maintains peak efficiency and eliminates annual tune-ups by controlling excess air with low-cost oxygen sensors. Initiated development of computational fluid dynamic (CFD) design tool for oil burners and initiated laboratory</p>	<p>low-cost, low-NOx version of FAB with small burner manufacturer to evaluate commercial potential. Demonstrate prototype self-tuning FAB, and continue refinements to control excess air. Continue developing a CFD design tool to improve accuracy. Continue technology transfer to industry through support of a 1998 Oil Heat Technology Conference. (BNL) (\$500)</p>	<p>burner concept improving design for lower cost, application testing, and demonstrations for potential industry partners. Demonstrate the use of Computational Fluid Dynamics (CFD) in the design of a new oil burner working in cooperation with an oil burner manufacturer. Continue technology transfer to industry through support for 1999 Oil Heat Technology Conference. (BNL) (\$500)</p>

### III. Performance Summary: BUILDING EQUIPMENT AND MATERIALS (Cont'd)

Activity	FY 1997	FY 1998	FY 1999
Space Conditioning and Cogeneration (Cont'd)	<p>confirmation tests. Continued to provide the oil heat industry with a mechanism for the transfer of research results through the 1997 Oil Heat Technology Conference, trade shows and educational programs. (BNL) (\$494)</p> <p>REFRIGERATION: This program supports the heating, ventilating, air-conditioning and refrigeration (HVAC&amp;R) industry with the technology base needed to increase energy efficiency, improve the quality of space conditioning, and adopt a new generation of chlorine-free refrigerants. The goal is to reduce annual energy use for space heating &amp; cooling, refrigeration and water heating by 30% to 60%. For new refrigerants, completed a Cooperative Research and Development Agreement (CRADA) with the chemical industry on global warming impact analysis of chlorine-free refrigerants and alternative</p>	<p>REFRIGERATION: Building on industry's vision of the future and a 1997 research agenda of "HVAC&amp;R Research for the 21st Century," revise program plans to increase program potential to achieve energy savings of 30% to 60%. Conduct an independent peer review of the program. Conduct an assessment of technical and market opportunities in the heating, air-conditioning, ventilation, refrigeration and water heating sectors in commercial and residential buildings. For new refrigerants, continue last phase of a industry-led, jointly-funded research program on materials compatibility and lubricants research for a new generation of</p>	<p>REFRIGERATION: In response to a 1997 industry research agenda "HVAC&amp;R Research for the 21st Century" and technology assessment results, continue a collaborative program of industry cost shared research focused in areas of high priority, including integration of equipment and distribution system, and improved quality of conditioned air. For new refrigerants, complete the successful seven-year, industry-led, jointly-funded program of materials compatibility and lubricants research which paved the way for a new generation of chlorine-free refrigerants to replace refrigerants which deplete the ozone layer. Complete laboratory support to</p>

### III. Performance Summary: BUILDING EQUIPMENT AND MATERIALS (Cont'd)

Activity	FY 1997	FY 1998	FY 1999
Space Conditioning and Cogeneration (Cont'd)	<p>technologies. Continued materials compatibility and lubricant research in a jointly-funded and industry-led program to replace refrigerants which deplete the ozone layer. Under a CRADA with Dupont, evaluated special refrigerant blends designed to improve efficiency at high outdoor temperatures and reduce utility peak loads. For refrigeration systems, conducted research with industry cost sharing to develop and demonstrate high efficiency technology breakthroughs for supermarket refrigeration systems, residential refrigerators, and soft drink vending machines. Began baseline refrigerator tests in a cost-shared CRADA with Frigidaire to develop a refrigerator using 50% less energy than current designs. Completed a major technology and market assessment of water heating and initiated effort to develop and demonstrate advanced residential and</p>	<p>chlorine-free refrigerants. Continue CRADA with DuPont to improve air conditioning performance at high outdoor temperatures by developing new heat exchangers to efficiently use new refrigerant blends. For refrigeration systems, continue research with industry cost sharing to develop and demonstrate high efficiency technology breakthroughs for supermarket refrigeration systems, residential refrigerators and soft drink vending machines. For residential refrigerators, evaluate component technologies under the cost-shared CRADA with Frigidaire to develop a refrigerator using 50% less energy than current designs. Initiate development of an innovative design concept for a heat pump water heater much lower in cost and easier to install than today's technology. Complete development of a nationally recognized method of test for thermal distribution</p>	<p>CRADA partner DuPont and a heat pump manufacturer in laboratory and field testing of a heat pump with improved performance at high outdoor temperatures. For refrigeration systems, complete laboratory support to CRADA partner Frigidaire to develop a pre-production refrigerator/freezer using 50% less energy than current designs. Demonstrate supermarket refrigeration/HVAC energy savings in field tests of new systems with industry partners. Continue development and begin field testing innovative heat pump water heater concepts much lower in cost and easier to install than conventional technology. Continue development of the proposed ASHRAE Standard for thermal distribution efficiency through demonstrations of improved designs by field validation testing. (ORNL, NIST, LBL, BNL, University of Maryland, Arthur D. Little)</p>

### III. Performance Summary: BUILDING EQUIPMENT AND MATERIALS (Cont'd)

Activity	FY 1997	FY 1998	FY 1999
Space Conditioning and Cogeneration (Cont'd)	commercial heat pump water heater technologies. Continued to develop and facilitate improved thermal distribution systems including the development of a nationally recognized test method for thermal distribution system efficiency. (ORNL, NIST, ARTI, University of Maryland, Arthur D. Little) (\$2,231)	system efficiency through publication of an ASHRAE method of test procedure public review. (ORNL, NIST, LBL, BNL, University of Maryland, Arthur D. Little) (\$3,130)	(\$3,130)
	FUEL CELLS FOR BUILDINGS: This activity works with industry in cost shared programs to develop and demonstrate fuel cell technologies which are cost effective and unique to buildings and are not being addressed by other fuel cell programs. Issued a competitive Program Research and development announcement (PRDA) for research and development of a processes for reforming natural to obtain Hydrogen for the fuel cell. Selected three cost sharing partners to investigate three	FUEL CELLS FOR BUILDINGS: This activity works with industry in cost shared programs to develop and demonstrate fuel cell technologies which are cost effective and unique to buildings and are not being addressed by other fuel cell programs. In FY - 1998 selection of the best of three reforming concepts will be made and the design of critical components for the selected process will begin. In the SBIR program, complete development of carbon monoxide tolerant anodes and low cost bi-polar plates. International Fuel	FUEL CELLS FOR BUILDINGS: This activity works with industry in cost shared programs to develop and demonstrate fuel cell technologies which are cost effective and unique to buildings and are not being addressed by other fuel cell programs. In FY-1999 fabrication and laboratory testing of the selected reformer will begin. Initiate the design of a laboratory breadboard PEM fuel cell for building applications. Initiate research into high temperature membrane materials, advanced CO tolerant and high

### III. Performance Summary: BUILDING EQUIPMENT AND MATERIALS (Cont'd)

Activity	FY 1997	FY 1998	FY 1999
Space Conditioning and Cogeneration (Cont'd)	different reforming technologies for natural gas. In the SBIR program, continue to develop two component concepts: low cost bi-polar plate using carbon fibers and carbon monoxide tolerant anodes. (International Fuel Cells, H2Burner Technologies, Energy and Environmental Research Corporation, Materials & Electrochemical Research, EIC Laboratories, Argonne National Laboratory) (\$985)	Cells, H2Burner Technologies, Energy and Environmental Research Corporation, Materials & Electrochemical Research, EIC Laboratories, Argonne National Laboratory) (\$1,000)	temperature catalysts. With an industrial partner, continue working with low cost bipolar plates derived from the SBIR program. (International Fuel Cells, H2Burner Technologies, Energy and Environmental Research Corporation, Materials & Electrochemical Research, EIC Laboratories, Argonne National Laboratory) (\$3,000)
	\$ 11,440	\$ 12,430	\$ 15,380
Lighting and Appliance	LIGHTING R&D: The goal of this activity is to develop the technology to reduce lighting energy use by 50 percent by the year 2010, saving consumers \$20 billion a year and saving 12 percent of all the electricity used in the United States each year. To achieve this goal, the program is undertaking work in three areas: advanced light sources; fixtures, controls and distribution	LIGHTING RD&D: Conduct a comprehensive technical peer review of all lighting activities using an independent panel of outside experts from industry and academia. Refocus or adjust projects as necessary based on panel report. Conduct an industry workshop to identify R&D and technology transfer needs for lighting controls, cofunded by NY State and EPA.	LIGHTING RD&D: Based on 1997 peer review and industry recommendations, refocus and expand lighting R&D program. Accelerate development of compact fluorescent lamps (CFL) and novel light distribution systems, and accelerate research on lighting controls and impacts.

### III. Performance Summary: BUILDING EQUIPMENT AND MATERIALS (Cont'd)

Activity	FY 1997	FY 1998	FY 1999
Lighting and Appliance (Cont'd)	<p>systems; and the impact of lighting on vision. The major focus of the program is on advanced light source research because of their importance in determining overall system efficiency, the high technical risk of lamp research, and the replacement opportunities due to their relatively short life and low cost.</p> <p>LIGHT SOURCES: Almost two-thirds of the electricity used for lighting buildings in the US is for incandescent and fluorescent lamps, costing consumers \$25 billion a year. Development of advanced, highly efficient light sources could cut these costs in half over the next 15 years. The program is developing advanced lamps to accomplish this goal in the near, mid and long term.</p> <p>NEAR-TERM: Initiated cost-shared development of a low-cost compact fluorescent</p>	<p>Initiate an effort to establish a comprehensive industry-DOE road map for lighting R&amp;D, building on the controls workshop and on a basic research road map for light sources developed in 1995 by industry as a joint initiative with DOE-EE, DOE-ER, EPRI and NSF.</p> <p>LIGHT SOURCES:</p> <p>NEAR-TERM: Continue cost-shared effort to develop a low cost compact fluorescent</p>	<p>LIGHT SOURCES:</p> <p>NEAR-TERM: Accelerate cost-shared effort to develop a low cost compact fluorescent</p>

### III. Performance Summary: BUILDING EQUIPMENT AND MATERIALS (Cont'd)

Activity	FY 1997	FY 1998	FY 1999
Lighting and Appliance (Cont'd)	<p>lamp (CFL) with an internal electronic power supply in cooperation with a major manufacturer. CFLs are four times more efficient than incandescent lamps, but have only 2 percent of the market because of their high cost largely due to the lamp's internal power supply.</p> <p>MID-TERM: The low-power sulfur lamp could be six to eight times more efficient than incandescent lamps, two times more efficient than fluorescent lamps, and have an operating life of 10 years or more. The quality of sulfur lighting is exceptional: it closely matches sunlight, but produces no harmful ultraviolet rays or heat. Continued heavily cost-shared effort to develop the fundamental lamp technology of the low-power sulfur lamp and a highly efficient, solid-state power source.</p>	<p>lamp (CFL) with an internal electronic power supply. Evaluate several new electronic circuit designs and select the one most capable of low-cost manufacture. Construct breadboard prototype and test. Begin effort to modify lamp components to operate compatibility with the new electronic circuit.</p> <p>MID-TERM: Continue cost-shared effort to develop a low-power sulfur lamp and power source. Optimize design of the laboratory prototype. Evaluate performance of each sub-system: bulb, power source, coupling and shielding, and light extraction. Evaluate system efficiency and light quality. Investigate possible failure modes and improve starting characteristics. Incorporate improvements into laboratory prototype.</p>	<p>lamp (CFL) with industry. Optimize the selected power supply circuit for performance and low-cost manufacture and construct an improved laboratory prototype. Continue to develop lamp components compatible with the power supply. Test integrated improved power supply and lamp systems.</p> <p>MID-TERM: Continue to optimize design and integrate the prototype low-power sulfur lamp with a highly efficient solid state power source. Using an independent laboratory, measure system efficiency and spectral characteristics of final prototype low- power lamp. Estimate manufacturing cost for lamp and power supply and perform a market study and identify candidate market entry points according the lamp's performance, features, cost, and other factors.</p>

### III. Performance Summary: BUILDING EQUIPMENT AND MATERIALS (Cont'd)

Activity	FY 1997	FY 1998	FY 1999
Lighting and Appliance (Cont'd)	<p>LONG-TERM: Continued to develop a new type of cathodo-luminescent lamp, which uses a diamond-like carbon filament. This "diamond lamp" project is cost-shared by DOE's Basic Energy Sciences (ER) and industry. This high-efficiency technology, could be produced in a wide variety of shapes and sizes and can be easily dimmed and controlled. Developed an initial laboratory prototype diamond lamp and made initial efficiency measurements.</p> <p>DISTRIBUTION AND CONTROLS: To achieve the energy saving potential of advanced light sources, new techniques need to be developed for distributing and utilizing the light they produce. This effort currently focuses on lighting</p>	<p>LONG-TERM: Continue development of a unique type of cathodo-luminescent lamp, the diamond lamp, with cost-sharing by DOE's Basic Energy Science (ER) and industry. Based on initial efficiency measurements, investigate methods to improve efficiency and operability. Evaluate the performance of the low energy phosphors used. Determine power source requirements and construct prototype power source.</p> <p>DISTRIBUTION AND CONTROLS: Continue the project to evaluate the use of state-of-the-art lighting controls in a federal office building. Analyze and evaluate the first year's data and prepare interim comprehensive report for</p>	<p>LONG-TERM: Continue development of a unique type of cathodo-luminescent lamp, the diamond lamp, with cost-sharing by DOE's Basic Energy Science (ER) and industry. Improve the initial prototype diamond lamp and test more efficient fluorescent phosphors. Determine the configuration and characteristics of the "diamond lamp" for successful market entry. Begin to evaluate the state-of-the-art in new types of light sources for instruments and displays, (e.g., light emitting diodes and electro-luminescent displays) to determine their applicability to building lighting.</p> <p>DISTRIBUTION AND CONTROLS: Complete the lighting controls project in a large Federal office building and report results to the GSA for application at other Federal facilities. Complete the fixture design competition by transferring the</p>



### III. Performance Summary: BUILDING EQUIPMENT AND MATERIALS (Cont'd)

Activity	FY 1997	FY 1998	FY 1999
Lighting and Appliance (Cont'd)	<p>controls and CFL fixtures. Continued work in a collaborative project with an electric utility and the General Services Administration (GSA) to field test and evaluate the latest electronic/computer control systems for lighting in a large Federal office building. Lessons learned here will be reported to the GSA for application at other Federal facilities. Another problem with CFLs is that they cannot often be used in conventional fixtures because of their size and shape. Assisted manufacturers in designing more efficient and pleasing fixtures for CFLs, particularly those that utilize dedicated sockets that will not accept incandescent lamps. Developed a plan for a national CFL fixture design competition and obtained cost-shared participation from industry.</p>	<p>sponsors. Continue to assist manufacturers in developing new fixtures for compact fluorescent lamps. Develop a reference manual for designing efficient compact fluorescent fixtures and disseminate to manufacturers. Continue to conduct workshops in fixture design for the fixture industry. Complete installation and evaluation of new types of CFL fixtures in a large hotel chain. Initiate the national design competition for CFL fixtures, co-sponsored with industry. Contestants will be students in industrial arts and engineering at universities and judges will be leading interior designers, manufacturers, and retailers.</p>	<p>winning student designs to participating manufacturers and complete arrangements for market introduction by the project's retail partners. Initiate an effort to evaluate several new technologies in telecommunications, defense and space science which may be useful for building lighting from areas such as: non-imaging optics, solid state optical devices, and materials science. Begin to develop methods to efficiently use optical fibers and hollow light guides to distribute light from highly efficient centralized light sources and/or solar concentrators and daylighting systems. Health care and educational facilities use proportionally much more lighting energy than other types of facilities. Perform a study of ways to tailor newly emerging lighting technology for increased use in schools, hospitals, and similar facilities.</p>

### III. Performance Summary: BUILDING EQUIPMENT AND MATERIALS (Cont'd)

Activity	FY 1997	FY 1998	FY 1999
Lighting and Appliance (Cont'd)	<p><b>IMPACTS OF LIGHTING:</b>            Since the main purpose of lighting is to improve vision, energy efficient lighting systems must be also evaluated on how they affect vision. Making these judgements on a sound scientific basis is difficult because of serious gaps in knowledge of the relationship between lighting and vision. There are no generally accepted means for optimizing lighting as it affects vision and the relationship between energy savings and visual quality is largely unknown. Completed long-term laboratory work on the effects of scotopic lighting on vision and present the results to industry. Further work on the use of scotopic lighting in buildings will depend upon industry participation. (GE, Fusion Lighting, LANL, LBNL, ORNL, Lighting Research Center) (\$2,366)</p>	<p><b>IMPACTS OF LIGHTING:</b>            Refocus work on the impact of lighting on vision on improving the visual quality and energy efficiency of outdoor lighting, particularly on streets and highways. Initiate a near-term project with broad, cost-shared industry support to test the feasibility of "mesopic lighting " which modifies the spectrum of high intensity outdoor lamps to give better color quality and visual effectiveness, thereby allowing the lamps to be operated on less energy. These improved high intensity lamps have the potential to be 50 percent more efficient while creating a safer and more pleasant nighttime environment for pedestrians and motorists. (GE, Fusion Lighting, LANL, LBNL, ORNL, Lighting Research Center, TBD) (\$2,400)</p>	<p><b>IMPACTS OF LIGHTING:</b>            Evaluate initial experimental results of mesopic lighting which modifies the spectrum of high intensity outdoor lamps to produce a better quality light that improves vision, thereby allowing lamps to be operated with less energy. Energy savings of 50 percent seem possible at little additional cost. Complete initial experiments in which subjects are tested in a modified auto drivingsimulator. Begin planning for field tests using mesopic street lights with co-funding and technical assistance from the four largest manufacturers of lighting in the U.S. (GE, Fusion Lighting, LANL, LBNL, ORNL, Lighting Research Center, TBD) (\$4,080)</p>

### III. Performance Summary: BUILDING EQUIPMENT AND MATERIALS (Cont'd)

Activity	FY 1997	FY 1998	FY 1999
Lighting and Appliance (Cont'd)	<p>Technology Access: TECHNOLOGY INTRODUCTION PARTNERSHIPS: Program fills the gap between traditional federal R&amp;D programs for new technologies (such as the Building Technology R&amp;D programs), and the mass-market for energy efficient products by removing market barriers. There are three major elements to the program: (1) conducting applied, focused development and pilot demonstration of emerging technologies with industry that increase the efficiency of appliances, heating, cooling, and refrigerating equipment, and building components like windows; (2) demonstrating markets for energy efficient products by organizing volume purchases and promoting energy efficient products with utilities, manufacturers, and home builders and (3) facilitating commercialization of energy</p>	<p>Technology Access: TECHNOLOGY INTRODUCTION PARTNERSHIPS: The major objectives for FY 1998 are to broaden demonstrations beyond lighting and washers; organize volume purchases beyond public housing into private multi-family housing; establish the Energy Star as a uniform national program that can be used by utilities as a platform to promote efficient appliances.</p>	<p>Technology Access: TECHNOLOGY INTRODUCTION PARTNERSHIPS: The major objectives for FY 1999 are to expand the program into commercial building technologies, broaden the program by adding more gas appliance demonstrations, and incorporate gas products into volume purchases, strengthen the links with research and development programs, and add to the portfolio of products in consumer education efforts.</p>

### III. Performance Summary: BUILDING EQUIPMENT AND MATERIALS (Cont'd)

Activity	FY 1997	FY 1998	FY 1999
Lighting and Appliance (Cont'd)	<p>efficient products for the mass-market by identifying very efficient products and educating consumers to invest in products that are significantly more efficient than mandated by appliance standards.</p> <p>EMERGING TECHNOLOGY DEMONSTRATIONS: The purpose of emerging technology demonstrations is to build manufacturer, utility, and consumer confidence in new, energy efficient technologies and products through cost-shared development and demonstrations with industry. Completed demonstrations of horizontal axis washer technology in commercial installations with U.S. manufacturers; demonstrated energy savings from horizontal axis washers with a major manufacturer in water-strapped community. Installed sulfur lamp demo at U.S. Air Force base. The sulfur lamp has been developed to demonstration stage</p>	<p>EMERGING TECHNOLOGY DEMONSTRATIONS: Demonstrate sulfur lamp in Air Force and U.S. Post office installations and disseminate results to aerospace and other industries. Demonstrate efficient water heating and hot water energy recovery technologies with industry.</p>	<p>EMERGING TECHNOLOGY DEMONSTRATIONS: Demonstrate a "drop-in" heat pump water heater for residential use with a major manufacturer, based on DOE R&amp;D programs. Develop a specification for the heat pump water heater to be used in organizing volume purchases. With a major manufacturer and gas utility partner, demonstrate a new engine-driven, integrated gas cooling and water heating technology. Demonstrate the energy savings potential from modifications to consumer electronics products that can reduce or eliminate power "leakage" in standby modes. Evaluate products from DOE</p>

### III. Performance Summary: BUILDING EQUIPMENT AND MATERIALS (Cont'd)

Activity	FY 1997	FY 1998	FY 1999
Lighting and Appliance (Cont'd)	through DOE - supported R&D.		buildings R&D programs for demonstrations, such as centralized light distribution system and desiccant cooling systems.
	VOLUME PURCHASES: The purpose of organizing volume purchases is to demonstrate markets to manufacturers for emerging products by organizing volume purchases. Assisted in developing specification for new round of advanced refrigerator purchase for public housing through competitive procurement with utility groups; expanded the commitments for 1996 refrigerator volume purchase to 60,000 refrigerators by public housing authorities. Implemented a volume purchase for clothes washers in cooperation with water utilities and housing buyers group.	VOLUME PURCHASES: Continue technical performance monitoring and evaluation of 60,000 apartment-sized refrigerators in public housing units. Organize buyers groups for compact fluorescent lighting, high-efficiency clothes washers, and window air conditioners.	VOLUME PURCHASES: Organize volume buyers to commit to a purchase of heat pump water heaters. Organize utilities to promote sales of high efficiency gas appliances, such as integrated space conditioning/water heaters and condensing furnaces.
	CONSUMER EDUCATION: The purpose of consumer	CONSUMER EDUCATION: Establish the Energy Star as the	CONSUMER EDUCATION: Add commercial products like

**III. Performance Summary: BUILDING EQUIPMENT AND MATERIALS (Cont'd)**

Activity	FY 1997	FY 1998	FY 1999
Lighting and Appliance (Cont'd)	education is to educate consumers on the value of purchasing energy efficient products. This is accomplished by identifying energy efficient products for consumers with the Energy Star designation and assisting Energy Star products with manufacturers, utilities and others who will promote Energy Star products directly to consumers. Launched a consumer education program for energy efficient appliances with EPA using the Energy Star label. Recruited 8 utilities to use the Energy Star as the aegis for promoting efficient consumer products; signed agreements with retail chains, local retailers' associations representing over 1,000 stores to promote Energy Star appliances. Added windows to the Energy Star portfolio. (ORNL, PNNL, D&R, Southeast Manufactured Housing Alliance) (\$4,432)	common program aegis for regional market transformation efforts and utility marketing and DSM programs. Begin recruiting manufacturers of high efficiency appliances and windows to label Energy Star products at the factory. Develop a protocol with FTC to allow incorporation of the Energy Star logo on the yellow "Energy Guide" label for qualified appliances. Monitor sales of Energy Star products to measure success of consumer education. (ORNL, PNNL, D&R, Southeast Manufactured Housing Alliance) (\$2,942)	chillers and boilers to the Energy Star product portfolio; add gas products like water heating technology to the Energy Star consumer education portfolio. Sign agreements with all major appliance manufacturers to apply voluntary Energy Star labels at the factory. Add new appliances, such as water heaters and dryers, to the Energy Star portfolio. Incorporate Energy Star as a voluntary element of the FTC "Energy Guide" label. Continue to measure sales of Energy Star products to measure success of the program. Initiate a campaign to educate consumers about the benefits of early retirement of inefficient residential appliances. (ORNL, PNNL, D&R, Southeast Manufactured Housing Alliance) (\$7,000)
	\$ 6,798	\$ 5,342	\$ 11,080

### III. Performance Summary: BUILDING EQUIPMENT AND MATERIALS (Cont'd)

Activity	FY 1997	FY 1998	FY 1999
Building Envelope R&D	<p>The goal of the Building Envelope R&amp;D Activity is to develop with industry proven energy efficient materials and envelope components, including windows, ready for commercialization. The use and development of environmentally benign and recyclable materials is a major driving force in the research agenda. Building Envelope research focuses on five elements: Thermal Insulation and Building Materials; Urban Heat Islands; Electrochromics; Superwindow Technology; and Advanced Glazings. A Technology Access unit is also included transferring the results emanating from the Urban Heat Island research and the Window research efforts. In accordance with the 1992 EPA Act requirements to work with industry, DOE sponsored the National Program Plan, version 4 (NPP4) for the thermal performance of building envelope systems and materials. The plan</p>	<p>The goal of the Building Envelope R&amp;D Activity is to develop with industry proven energy efficient materials and envelope components, including windows. The use and development of environmentally benign and recyclable materials is a major driving force in the research agenda. Building Envelope research focuses on five elements: Thermal Insulation and Building Materials; Urban Heat Islands; Electrochromics; Superwindow Technology; and Advanced Glazings. A Technology Access unit is also included transferring the results emanating from the Urban Heat Island research and the Window research efforts.</p>	<p>The goal of the Building Envelope R&amp;D Activity is to develop, with industry, proven energy efficient materials and envelope components, including windows. The use and development of environmentally benign and recyclable materials is a major driving force in the research agenda. Building Envelope research focuses on five elements: Thermal Insulation and Building Materials; Urban Heat Islands; Electrochromics; Superwindow Technology; and Advanced Glazings. A Technology Access unit is also included transferring the results emanating from the Urban Heat Island research and the Window research efforts.</p>

### III. Performance Summary: BUILDING EQUIPMENT AND MATERIALS (Cont'd)

Activity	FY 1997	FY 1998	FY 1999
Building Envelope R&D (Cont'd)	<p>was developed by the Building Environment and Thermal Envelope Council (BETEC) under the auspices of the National Institute of Building Sciences (NIBS). DOE received the NPP4 in FY 1995. This plan outlined research needs for enhancing the energy efficiency of buildings defined by the building science industry and practitioners. DOE used the findings of this plan to develop a program of research in close cooperation with industry. The program initiated a new relationship with industry.</p> <p>Building Envelope R&amp;D includes: THERMAL INSULATION AND BUILDING MATERIALS: Six new CRADAs were initiated in FY 1997, which addressed research needs identified in the NPP. In addition, a National user facility, the Building Technology Center (BTC) at Oak Ridge National Laboratory, was established to facilitate</p>	<p>Building Envelope R&amp;D includes: THERMAL INSULATION AND BUILDING MATERIALS: Continuing industry driven research and development, expand use of the National User facility by industry (six additional CRADA's are being developed). FY 1998 projects include: wind resistant roofing, manufacturing processes for super insulations,</p>	<p>Building Envelope R&amp;D includes: THERMAL INSULATION AND BUILDING MATERIALS: The FY 1999 program will continue the energy performance focus activities while at the same time further engaging industry in it's efforts to address the environmental context of advanced materials and structures. The Total Equivalent</p>



### III. Performance Summary: BUILDING EQUIPMENT AND MATERIALS (Cont'd)

Activity	FY 1997	FY 1998	FY 1999
Building Envelope R&D (Cont'd)	cooperative research projects among industry, academia and government. FY 1997 Research, development, demonstration and deployment projects include: Zero ozone depletion and global warming foam insulations, high R-value super insulations, advanced manufacturing processes for super insulations, thermal performance label for whole wall R-value, R-30/30 roof (30 year life/ R-value = 30). (ORNL, LBNL) (\$1,880)	thermal performance label for whole wall R-value, R-30/30 roof (30 year life/R-value = 30), participation in International efforts to quantify total wall performance, resolve technical issues regarding replacement blowing agents for thermal insulating foams, (i.e., Total Equivalent Warming Index [TEWI] issues), and a new program on sustainable insulations and envelopes. (ORNL, LBNL) (\$2,290)	Warming Index (TEWI), a joint industry government process to develop a descriptor of alternative refrigerant and insulation blowing agents, pointed out the need for a comprehensive energy and environmental assessment of advances and alternatives. The FY 1999 program will focus on the government/industry cooperative program to "level the playing field," by developing a uniform analytical basis for energy and environmental performance. FY 1999 projects include: Measurement and analysis of significant energy savings of attic, duct, wall, window, roof, and foundation technologies. Determination of performance characteristics, and development of advanced manufacturing processes for sustainable, environmentally safe, affordable, next generation insulation alternatives, including superinsulations and non-HCFC foams. Evaluation of indigenous

### III. Performance Summary: BUILDING EQUIPMENT AND MATERIALS (Cont'd)

Activity	FY 1997	FY 1998	FY 1999
Building Envelope R&D (Cont'd)			insulating materials such as straw (baled and sheaves), expanded clays, sawdust, perlite, vermiculite, lava, fly ash and other natural or waste materials. Development and demonstration of advanced building insulation application technology concepts, for retrofit and new construction. The Building Envelope Research Center will measure and evaluate overall system thermal performance for walls and roofs under real world conditions. Advanced self-drying roof systems with an effective R-value of 30, and service life of thirty years (R-30/30 roof) will become available in the commercial roofing industry. (ORNL, LBNL) (\$3,090)
	URBAN HEAT ISLAND RESEARCH: Continued developing materials and ecological strategies to reduce energy requirements for air conditioning and improve	URBAN HEAT ISLAND RESEARCH: Coordinate heat island studies, demonstrations, and technology marketing with other agencies including EPA, NASA, DOT, HUD, USDA,	URBAN HEAT ISLAND RESEARCH: Continue coordinating heat island studies with other Federal agencies, roofing and pavement product manufacturers. With the National

### III. Performance Summary: BUILDING EQUIPMENT AND MATERIALS (Cont'd)

Activity	FY 1997	FY 1998	FY 1999
Building Envelope R&D (Cont'd)	<p>environmental conditions of buildings. Research supported accelerated development of highly reflective building products, improving the integrity of building envelopes, and achieving faster and more extensive monitoring results at demonstrations on Federal facilities and in local communities, with the involvement of private sector partners. Research provided the scientific foundation to bring significant savings to households nationwide; potential return of \$10 billion per year was demonstrated if full deployment of the proposed market development strategy is applied. (LBNL) (\$681)</p>	<p>USAID and roofing products manufacturing companies. Analyze urban air temperature, air quality, and satellite imagery data in several U.S. cities. Model community-wide cooling effects of light surfaces and vegetation in urban communities on building energy use, air temperature and ozone formation. Continue collaboration with pavement and roofing industry to adopt standardized reflectivity measurement and product labeling. Prepare a database of highly reflective roofing and pavement materials. Provide technical support establishing a system for air pollution control credits for using highly reflective surfaces and vegetation plantings in urban areas to offset anticipated pollution from new urban development. Coordinate procurement specifications with GSA and other Federal agencies to facilitate use of highly reflective surfaces on government</p>	<p>Laboratories, continue analyzing urban air temperature, air quality and satellite imagery data in additional U.S. cities. Tools will be developed for cities to use in quantifying community-wide cooling effects of light surfaces and vegetation on building energy use, air temperature and ozone formation. Implement standardized and voluntary reflectivity measurement and product labeling in conjunction with the Energy Star program. Expand the database of highly reflective roofing and pavement materials. Continue establishment of air pollution credits for reflective surfaces and vegetation for urban development as an offset to ozone standards. Continue work with GSA to use highly reflective surfaces on Federal facilities. (LBNL, ORNL) (\$700)</p>

### III. Performance Summary: BUILDING EQUIPMENT AND MATERIALS (Cont'd)

Activity	FY 1997	FY 1998	FY 1999
Building Envelope R&D (Cont'd)	<p>The Windows and Glazing activity develops advanced window technologies and the design, rating and information tools needed to optimize the use of these technologies. Research on advanced window technologies and processes focuses on electrochromics, very high-R value "SuperWindow" technology and spectrally selective "cool" windows. Performance and simulation research establishes the basis for the technically credible rating of window and glazing products being adopted by industry's voluntary energy rating system. Under "Technology Access", the SuperWindow collaborative works with industry to foster a market transformation leading to a doubling of the average energy efficiency of annual window sales.</p>	<p>facilities. (LBNL, ORNL) (\$700)</p> <p>The Windows and Glazing activity develops advanced window technologies and the design, rating and information tools needed to optimize the use of these technologies. Research on advanced window technologies and processes focuses on electrochromics, very high-R value "SuperWindow" technology and spectrally selective "cool" windows. Performance and simulation research establishes the basis for the technically credible rating of window and glazing products being adopted by industry's voluntary energy rating system. Under "Technology Access", the SuperWindow collaborative works with industry to foster a market transformation leading to a doubling of the average energy efficiency of annual window sales.</p>	<p>The Windows and Glazing activity develops advanced window technologies and the design, rating and information tools needed to optimize the use of these technologies. Research on advanced window technologies and processes focuses on electrochromics, very high-R value "SuperWindow" technology and spectrally selective "cool" windows. Performance and simulation research establishes the basis for the technically credible rating of window and glazing products being adopted by industry's voluntary energy rating system. Under "Technology Access", the SuperWindow collaborative works with industry to foster a market transformation leading to a doubling of the average energy efficiency of annual window sales.</p>

### III. Performance Summary: BUILDING EQUIPMENT AND MATERIALS (Cont'd)

Activity	FY 1997	FY 1998	FY 1999
Building Envelope R&D (Cont'd)	<p><b>ELECTROCHROMIC RESEARCH:</b> Continued both contractors for first stage of Phase II of the cooperative agreement for the electrochromics government-industry partnership; and continued the National laboratories core research team to support the industry partnership, other industry efforts, fundamental research affecting the next generation technologies; materials characterization; and new deposition technologies. The partnership is a multiphase program to develop and commercialize electrochromic windows. In late FY 1996, an interim Phase II.a was awarded to resolve longer term durability of large electrochromic samples. The goal is to develop full size electrochromic prototypes ready for demonstration, and acceptable in terms of cost and performance with early architectural markets. The Phase II cooperative agreement, scheduled to be</p>	<p><b>ELECTROCHROMIC RESEARCH:</b> Continue Phase II of the cooperative agreement for the electrochromics government-industry partnership; and continue the National laboratories core research team. In FY 1998, the winning team(s) are being selected to develop a pre-production line for intermediate size windows. Also, Mobile Window Thermal Testing (MoWiTT) facility for conducting field tests will test mock-ups of the first full size electrochromic skylights prototypes are being completed. In addition to the Phase II research DOE continues to conduct, and support industry with, fundamental research aimed at the next generation lower cost systems applicable to widespread adoption. In FY 1998, test of linear arrays are completed and technical assistance is being provided to transfer ion-beam deposition technology to industry. This technology is applicable to</p>	<p><b>ELECTROCHROMIC RESEARCH:</b> Continue the cooperative agreement for the electrochromics government-industry partnership. Continue the National laboratories core research team which supports the industry partnership. During FY 1999, industry designs for an automated production line for full size windows will be completed and implementation initiated to be operational by 2001 -- producing full size windows ready for demonstration and acceptable in terms of cost and performance with early architectural markets. Full size prototypes windows and skylights will be fabricated (non-automated) in FY 1999 for interim field testing. This phase will conduct field testing and conclude in FY 1999. DOE will also provide technical support to US industry in durability testing. In FY 1999, technical assistance for ion-beam deposition</p>

### III. Performance Summary: BUILDING EQUIPMENT AND MATERIALS (Cont'd)

Activity	FY 1997	FY 1998	FY 1999
Building Envelope R&D (Cont'd)	completed in FY 1998, will be completed and field tested in FY 2000. In addition to the Phase II research which focuses on nearer term applications, DOE will conduct, and support industry with, fundamental research aimed at the next generation lower cost systems applicable to widespread adoption. In FY 1996 and FY 1997, initial industry evaluation of ion-beam enhanced deposition technology was conducted, resulting in the design of a linear array of ion guns for coating full size prototypes. (LBNL, NREL, GO) (\$3,240)	both electrochromic and durable (i.e. retrofit) low-E/spectrally selective coatings. Industry partners are expected to move to pilot plant demonstrations of ion-beam technology after 1998. (LBNL, NREL, GO) (\$3,815)	technology will be provided for upgrades based on industry tests and scale up, and evaluation of new coatings optimized for this process. (LBNL, NREL, GO) (\$4,415)
	<b>SUPERWINDOW TECHNOLOGIES:</b> Maintained the technology base, including the materials and systems analytic and testing capability to support industry development of high-performance superwindow and spectrally selective window technologies. Support continued of the technology base (user	<b>SUPERWINDOW TECHNOLOGIES:</b> Maintaining the technology base, including the materials and systems analytic and testing capability to support industry development of high-performance superwindow and spectrally selective window technologies. Continuing expansion of the technology base	<b>SUPERWINDOW TECHNOLOGIES:</b> Continue materials and systems analytic and testing capability to support industry development of high-performance superwindow and spectrally selective window technologies particularly for small to medium-sized window companies. Continue support for

### III. Performance Summary: BUILDING EQUIPMENT AND MATERIALS (Cont'd)

Activity	FY 1997	FY 1998	FY 1999
Building Envelope R&D (Cont'd)	facilities, engineering design tools, etc.) for assisting industry, particularly small to medium window companies, in upgrading products. Defer until FY 1998 expansion of support for development of durable coatings utilizing ion-beam enhanced deposition technology. (LBNL) (\$242)	(user facilities, engineering design tools, etc.) for assisting industry, particularly small to medium window companies, in upgrading products. Expanding support for development of durable coatings utilizing ion-beam enhanced deposition technology to provide industry with a detailed assessment of the performance and benefits. The new thermal and solar coating technologies are resulting in more than doubling the "capture potential" of energy-efficient windows through the retrofit market products produced by small- to medium-sized manufacturers and the export market. (LBNL) (\$350)	development of durable coatings utilizing ion-beam enhanced deposition technology. (LBNL) (\$350)
	ADVANCED GLAZING (Performance and Simulation Research): Continued laboratory and field tests of advanced glazing technology. Industry's highest priority for DOE is to provide the research and technical	ADVANCED GLAZING (Performance and Simulation Research): Continuing laboratory and field tests of advanced glazing technology as per industry priorities. WINDOW 5X was developed having the capabilities	ADVANCED GLAZING (Performance and Simulation Research): Continue laboratory and field tests of advanced glazing technology, performance and simulation research. DOE will continue to work with the

### III. Performance Summary: BUILDING EQUIPMENT AND MATERIALS (Cont'd)

Activity	FY 1997	FY 1998	FY 1999
Building Envelope R&D (Cont'd)	<p>support for a fair, accurate, and technically credible window energy rating system. DOE has been working closely with the technical committees of the National Fenestration Rating Council (NFRC), the American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE), and the American Society for Testing and Materials (ASTM) to guide this research. International collaboration on this advanced glazing performance research continued, including technical support to the International Standards Organization (ISO) TC-163/WG-2. The NFRC rating program is being used for the new ISO standards which will aid U.S. firms' ability to compete in foreign markets. A public domain computer program WINDOW 5 Beta version with advanced modules (THERM 2.0 (32 Bit) heat transfer module; LAMINATE; etc.) was completed with modules released.</p>	<p>to optimize the design of a wider range of products. Technical support of the basic rating system is being completed and research is continuing to support the NFRC comprehensive rating program, in accordance with their five year plan. Continuing technical support of the SuperWindow Collaborative (a.k.a. Efficient Window Collaborative). Technical support of NFRC's initial commercial building windows guidelines is being completed. An ad hoc "cross society" review team (e.g., NFRC, Primary Glass Manufacturers' Council (PGMC), American Architectural Manufacturers Association (AAMA), American Institute of Architects (AIA), etc.) is formed to guide the development of the initial guidelines and to define future products, including the commercial building fenestration handbook, computer design tools, and a key architect pilot demonstration project. (LBNL,</p>	<p>National Fenestration Rating Council (NFRC) and other technical associations to guide the research for the energy rating system. The NFRC rating program is being used for new International Standards Organization (ISO) standards which will aid U.S. firms' ability to compete in foreign markets. Continue development and complete draft of the Commercial Buildings Fenestration Handbook; complete initial modules of supporting computer design tools. Initiate key architect pilot demonstration project to evaluate and revise the design tools and strategies for use of the handbooks and tools. The results from this project will identify future needs for product development. (LBNL, NFRC, Univ. of Mass., FSEC) (\$1,594)</p>



### III. Performance Summary: BUILDING EQUIPMENT AND MATERIALS (Cont'd)

Activity	FY 1997	FY 1998	FY 1999
Building Envelope R&D (Cont'd)	<p>The WINDOW 5X program series will have new capabilities to optimize the design of a wider range of products (e.g., angle and spectrally selective coatings, vinyl lineals, skylights, export windows, curtain walls, etc.) and a lower cost of designing and rating all products. In FY 1997, technical support of the basic rating system was completed and research shifted to support the NFRC comprehensive rating program, in accordance with their five year plan, and to support the SuperWindow Collaborative (a.k.a. Efficient Window Collaborative). Also, technical support was provided for NFRC's initial commercial building windows guidelines. (LBNL, NFRC, Univ. of Mass., Florida Solar Energy Center [FSEC]) (\$849)</p> <p>Technology Access includes: HIGHLY REFLECTIVE</p>	<p>NFRC, Univ. of Mass., FSEC) (\$894)</p> <p>Technology Access includes: HIGHLY REFLECTIVE</p>	<p>Technology Access includes: HIGHLY REFLECTIVE</p>

**III. Performance Summary: BUILDING EQUIPMENT AND MATERIALS (Cont'd)**

<u>Activity</u>	<u>FY 1997</u>	<u>FY 1998</u>	<u>FY 1999</u>
Building Envelope R&D (Cont'd)	SURFACES: No Activities. (\$0)	SURFACES: Publicizing results of Urban Heat Island Research and support other groups including: roofing manufacturers, utility companies, air quality management districts, local governments, other Federal agencies, and non-governmental organizations in implementing the research recommendation. Evaluating community benefits and costs of using highly reflective roofing and pavement materials in combination with urban forestry strategies to reduce formation of urban heat islands and their detrimental effects. Establishing partnerships and leverage support from other agencies and organizations and programs with interest in managing urban heat islands and their detrimental effects. Developing cost effective strategies and materials to help implement results of urban heat island research. Supporting existing program partners and	SURFACES: Continue implementing recommendations of Urban Heat Island research. Continue to promote benefits in communities in terms of energy efficiency, carbon reductions and effects on ambient air temperature. Expand program to fifteen more target cities for an end of year total of twenty-eight. (LBNL, American Forests, ORNL) (\$572)

### III. Performance Summary: BUILDING EQUIPMENT AND MATERIALS (Cont'd)

Activity	FY 1997	FY 1998	FY 1999
Building Envelope R&D (Cont'd)	<p>enlist additional partners to further expand potential applications for energy efficiency in buildings, improve community environment, and expand market opportunity for use of highly reflective surfaces as an integral part of sustainable development in cities. (LBNL, American Forests) (\$100)</p> <p>SUPERWINDOW COLLABORATIVE: Provided technical assistance program to manufacturers, particularly for small to medium companies, for industry restructuring in response to increased demand. Partnerships with key component producer teams and key companies, key user groups and the NFRC collaborative were implemented. Initial projects included both pilot regional projects and projects focused on the development and adaptation of DOE/LBL computer tools (e.g., Alpha version, multi-media</p>	<p>enlist additional partners to further expand potential applications for energy efficiency in buildings, improve community environment, and expand market opportunity for use of highly reflective surfaces as an integral part of sustainable development in cities. (LBNL, American Forests) (\$100)</p> <p>SUPERWINDOW COLLABORATIVE: Expand technical assistance program to manufacturers, particularly to small to medium companies, for industry restructuring in response to increased demand. Partnerships are implementing action plans. Projects are focusing on the development and adaptation of DOE/LBL computer tools (WINDOW 5 and RESFEN), information products and industry based training tools development continued. Evaluating pilot regional projects and revise the new tools and</p>	<p>enlist additional partners to further expand potential applications for energy efficiency in buildings, improve community environment, and expand market opportunity for use of highly reflective surfaces as an integral part of sustainable development in cities. (LBNL, American Forests) (\$100)</p> <p>SUPERWINDOW COLLABORATIVE: Expand technical assistance program to manufacturers. New projects continue on the development and adaptation of DOE/LBL computer tools (WINDOW 5 and RESFEN), information products and industry based training tools. In FY 1997 and FY 1998, pilot regional projects were initiated to evaluate and revise the new tools and information products. Regional projects will be expanded. During FY 1998, the industry-sponsored Efficient Windows Collaborative (EWC)</p>

### III. Performance Summary: BUILDING EQUIPMENT AND MATERIALS (Cont'd)

Activity	FY 1997	FY 1998	FY 1999
Building Envelope R&D (Cont'd)	<p>RESFEN with DOE-2 engine), information products and industry based training tools. The new computer tools will reduce the cost of producing and rating new designs and provide for low-cost, user friendly specification and selection of energy efficient windows. In FY 1997, pilot regional projects were initiated to evaluate and revise the new tools and information products. Initial regional projects included both sunbelt and frostbelt states. The Collaborative also coordinated and leveraged other Federal and regional programs (e.g., education, training, promotion and endorsements) affecting selection and specification of efficient windows. Detailed analyses for establishing criteria for Federal endorsements (Collaborative support, Energy Star, etc.) were developed and were reviewed by the Collaborative with recommendations provided to</p>	<p>information products. In FY 1998, the first cycle of these regional projects are being completed. Regional projects are being expanded (cycle 2) to new locations with the revised tools and products. Also, providing support for initial implementation, by user and producer teams of technical assistance, training and education projects. User and Producer teams are leveraging DOE investments by over 20 to 1.</p> <p>Collaborative teams' activities to increase demand and provide technical assistance are facilitating a major transformation of the industry: Companies selling over 90% of all windows are making incremental improvements in over half of their products. In FY 1998, widespread implementation of the program began: tools and information products are being provided to manufacturers who</p>	<p>Project was organized to address the implementation of education, training and technical assistance programs. The DOE role focuses on technical support of these activities through the EWC and technical support directly with industry on their development of advanced technologies. This support involved demonstration projects, analysis of results, and preparation of technically sound guidelines and design and training tools. For example, during FY 1998, demonstration results showed significant energy saving and also first cost saving for builders where high performance spectrally selective windows allowed for smaller, less expensive air conditioning equipment. Further demonstrations, analytic support and training will allow builders in several sunbelt states to duplicate these benefits during FY 1999. New glazing technologies can reduce the cooling load in sunbelt</p>

### III. Performance Summary: BUILDING EQUIPMENT AND MATERIALS (Cont'd)

Activity	FY 1997	FY 1998	FY 1999
Building Envelope R&D (Cont'd)	<p>DOE.</p> <p>Collaborative teams' activities to increase demand and provide technical assistance will facilitate a major transformation of the industry leading to a doubling of the average energy efficiency of annual window sales in the target year (originally 2005) over the base year (1991). Supporting goals include increasing the market share of efficient glazing (e.g., low-E, solar control) from 35% to over 80 to 90%. Companies selling over 90% of all windows will make at least incremental improvements in rated energy performance with major improvements made in over half of their products. (LBNL, Univ. of Minn., FSEC, Alliance to Save Energy (ASE)) (\$950)</p>	<p>produce over 90% of all windows; over 50% of all window customers are being reached, and detailed training by producer and user teams are being provided to manufacturers who produce over 70% of all windows. (LBNL, Univ. of Minn., FSEC, ASE) (\$1,000)</p>	<p>homes by 40-70 percent. (LBNL, Univ. of Minn., FSEC, ASE) (\$1,000)</p>
	\$ 7,842	\$ 9,149	\$ 11,721

**III.    Performance Summary: BUILDING EQUIPMENT AND MATERIALS (Cont'd)**

<u>Activity</u>	<u>FY 1997</u>	<u>FY 1998</u>	<u>FY 1999</u>
Building Equipment and Materials Total	\$ 26,080	\$ 26,921	\$ 46,181

BUILDING TECHNOLOGIES  
BUILDING TECHNOLOGY, STATE, AND COMMUNITY SECTOR  
(dollars in thousands)

CODES AND STANDARDS

**I. Mission Supporting Goals and Objectives:**

**I.A. Statement of Mission**

The mission of the Codes and Standards program is to implement a legislatively mandated, multi-year effort to improve the energy efficiency in the Nation's buildings through energy efficiency standards, codes and guidelines for buildings, building equipment, and appliances. Setting efficiency standards leads to substantial increases in the average energy performance of buildings and equipment. This mission will be accomplished by early involvement of stakeholders and relevant Federal and state agencies in order to maximize benefits and minimize burdens utilizing the best, new, cost-effective, and environmentally friendly technologies.

The Codes and Standards activity consists of the following two program activity areas:

**Lighting and Appliance Standards:**

During its typical operating lifetime of 10 to 15 years, the operating cost of an appliance may be several times greater than its initial purchase price. Nevertheless, many consumers do not consider energy efficiency when making their purchases. Although the energy efficiency of most products can be significantly improved, manufacturers have been reluctant to invest in more efficient technology that may not be accepted in the highly competitive marketplace. Recognizing the large potential for energy savings, many states began to prescribe minimum energy efficiency standards for appliances. In response to the burden of complying with a myriad of differing state standards, manufacturers supported the development of Federal standards that would preempt those of the states.

The Energy Policy and Conservation Act (EPCA) established a conservation program for major household appliances including furnaces, water heaters, refrigerators and freezers, central air conditioners and central air conditioning heat pumps, room air conditioners, dishwashers, clothes washers, clothes dryers, direct heating equipment, pool heaters, kitchen ranges and ovens, fluorescent ballasts, and television sets. The Energy Policy Act of 1992 (EPAct) expanded the coverage to include commercial

**I. Mission Supporting Goals and Objectives: CODES AND STANDARDS (Cont'd)**

building heating and air conditioning equipment, water heaters, certain incandescent and fluorescent lamps, distribution transformers, and electric motors. EPCAct also established maximum water flow rate requirements for certain plumbing products and provides for voluntary testing and consumer information programs for office equipment, luminaires, and windows.

The program consists of essentially three parts: testing, labeling, and mandatory energy conservation standards. The Department is to prescribe test procedures that measure the energy efficiency and energy use and provide an estimate of annual operation cost of each appliance. The Federal Trade Commission (FTC) is required to prescribe labeling rules for the residential appliances. The Department and FTC share responsibility for labeling of the commercial equipment. Through amendments to EPCA, Congress prescribed initial Federal energy efficiency standards and established schedules for DOE review of these standards. The Department is required to promulgate amended energy efficiency standards designed to achieve the maximum improvement in energy efficiency which the Secretary determines are technically feasible and economically justified.

The Department actively encourages the participation and interaction of all interested parties at all stages of the rulemaking process. Early and frequent interactions among manufacturers, efficiency/environmental advocates, states, utilities, retailers and consumers provide a balanced discussion on potential standards levels as well as critical information required to conduct the analysis. In 1995, the Department examined, through a series of stakeholder meetings and interviews, issues surrounding the appliance standards program. The findings from these meetings and interviews became the basis for a rule outlining procedural and analytical changes for the appliance standards process which was published in July 1996. This new process will avoid the recurrence of problems similar to those that surfaced in 1994 and 1995 by ensuring: early involvement of stakeholders; increased predictability of the rulemaking timetable; increased use of industry expertise, early elimination of impractical or problematic design options, enhanced analysis of impacts, improved analytical methods; and support of consensus rulemaking. these initiatives will be implemented to facilitate the development of future rules. The Department is also exploring the relationship between market-pull approaches and standards and examining multiple paths to reach the same energy conservation goal. Among other factors, the Department is examining alternatives which maximize consumer benefits and minimize negative impacts on manufacturers and others. Such alternatives could include product labeling and education programs to feature the benefits of energy-efficient equipment; yet at the same time recognizing the market niche which exists for certain less efficient products.

In fiscal year 1999, utilizing the new rulemaking process, the Department will 1) revise test procedures as required by manufacturers to ensure that innovative designs can be properly tested; 2) perform engineering and economic analyses to evaluate cost-effective



I. **Mission Supporting Goals and Objectives:** CODES AND STANDARDS (Cont'd)

energy efficiency standards; and 3) begin rulemaking to revise standards, as required by legislation, in response to changes in the consensus standards for commercial equipment.

Building Standards and Guidelines:

Technical feasibility and cost effectiveness are key to designing and constructing buildings that are more comfortable than today's buildings yet require less than one-third as much energy. However, several market barriers prevent architects, engineers, and builders from doing so. Those who design and construct buildings (often not the same people who own and operate the buildings) tend to focus on the first cost rather than operating costs. Building operating costs are often hidden and passed on to others. Information on the feasibility, cost, and benefits of improving building energy efficiency is often not available.

Building energy standards and guidelines can assist in overcoming such barriers. The Building Standards and Guidelines program provides technical assistance to States, designers and builders in implementing codes, assistance to states to update and implement their building energy codes; assistance to building industry voluntary codes organizations to upgrade their codes to include measures which are technically feasible and cost-effective; and promulgates Federal building energy efficiency standards. The Building Standards and Guidelines program strategy is to promote, assist, and act as a catalyst in developing and implementing building energy efficiency codes, standards, and guidelines that are technically feasible, economically justified, and environmentally beneficial. By working in the market to eliminate the most inefficient technologies and building practices, this program complements the Department's efforts to develop and introduce advanced, highly efficient technologies.

In fiscal year 1999, the Department will focus on: (1) the benefits of newly adopted state codes and recently promulgated Federal codes by providing technical assistance and incentive funding to support training of designers, builders, and code officials for implementation of these new codes; (2) the promulgation of upgraded Federal standards; and (3) support of improvements to the next generation voluntary residential code and completion of the voluntary commercial code.

I. **Mission Supporting Goals and Objectives:** CODES AND STANDARDS (Cont'd)

I.B. Program Benefits

At the proposed funding levels, the Codes and Standards Program is estimated to yield the following benefits:

METRIC	2000	2010	2020
Primary Energy Displaced (Quads)	0.01	0.83	2.19
Energy Cost Savings (\$B)	0.06	5.69	14.71
Carbon Reductions (MMTons)	0.18	17.57	46.11

I.C. Performance Goals

The goal of Codes and Standards programs is to increase baseline efficiency levels for regulated residential appliances, commercial and industrial end-use technologies, and the Nation's building stock. The Codes and Standards programs will save consumers and businesses over \$10 billion annually by the year 2020. These savings and lower costs increase profits of business while providing savings for consumers that can be used to purchase other goods in the economy. In addition, more efficient products are more competitive internationally and have environmental benefits from reduced atmospheric emissions.

Accomplishment Summary

Lighting and Appliance Standards

FY 1997

The Appliance and Lighting standards Program began implementing its new rulemaking process which includes an annual procedure in which stakeholders are consulted in determining the prioritization of rulemakings.

-- Final rules for energy conservation standards were issued for refrigerator products and for room air conditioners.

I. **Mission Supporting Goals and Objectives:** CODES AND STANDARDS (Cont'd)

- Notices of Proposed Rulemaking (NPR) were issued to incorporate legislated standards and test procedures for plumbing equipment and large electric motors.
- Final rules to amend test procedures were issued for furnaces/boilers, vented home heating equipment and pool heaters, fluorescent and incandescent lamps, clothes washers, kitchen ranges and ovens, and externally vented refrigerators.

FY 1998

- Issue final rule for energy conservation standards for kitchen ranges and ovens.
- Issue NPRs for energy efficiency standards for lamp ballasts and water heaters.
- Issue Advance Notice of Proposed Rulemaking (ANOPR) for energy conservation standards for clothes washers.
- Initiate energy conservation standards rulemaking for residential central air conditioners/heat pumps.
- Issue final rule to amend test procedures for water heaters, including small and instantaneous water heaters.
- Issue final rule to incorporate legislated standards and test procedures for plumbing equipment and large electric motors.
- Issue NPR to amend test procedures for residential central air conditioners/heat pumps.
- Issue determination regarding test procedures and standards for electric distribution transformers.

FY 1999 Planned

- Issue final rule regarding energy conservation standards for lamp ballasts and water heaters.
- Issue NPR for energy conservation standards for clothes washers.

I. **Mission Supporting Goals and Objectives:** CODES AND STANDARDS (Cont'd)

- Issue ANOPR for energy conservation standards for residential central air conditioners/heat pumps.
- Issue final rule for test procedures for residential central air conditioners/heat pumps.
- Issue NOPR regarding test procedures for electric distribution transformers.
- Issue NOPR to incorporate legislated standards and test procedures for commercial HVAC and water heaters.
- Initiate rulemaking to amend test procedures for dishwashers.
- Initiate energy conservation standards rulemaking for electric distribution transformers and large electric motors (1-200 hp).
- Initiate determinations regarding test procedures and standards for small electric motors and high intensity discharge (HID) lamps.

Building Standards and Guidelines

1994-1997:

- Assisted 32 states in updating or implementing their residential building energy efficiency codes. As part of this process, achieved over \$2.7 million in cost sharing with state, utility, and producer partners.
- Assisted in the updating and simplification of the Model Energy Code (MEC) for residential buildings. Developed and disseminated tools that simplify the process of complying with the Code. Assisted in the development of the next generation voluntary commercial building energy standard (American Society of Heating, Refrigerating and Air Conditioning Engineers/Illuminating Engineering Society (ASHRAE/IES) Standard 90.1-1989R) for public review. This updated standard is expected to cost effectively achieve savings of 25 percent over the current voluntary standard.

I. **Mission Supporting Goals and Objectives:** CODES AND STANDARDS (Cont'd)

FY 1998:

- Ten states are being assisted in updating or implementing their residential building energy efficiency codes to the 1998 Model energy Code or early adopters version of the next generation code, Standard 90.1-1989R.
- Issue final rules regarding standards for energy efficient construction in Federal residential and commercial buildings.
- Tools that simplify the process of complying with ASHRAE/IES Standard 90.1 - 1989 and upgraded successor for commercial building energy consumption are being improved and disseminated.

FY 1999 Planned:

- Assist 10 states in implementation of ASHRAE/IES Standard 90.1 - 1989R using DOE-developed tools and above code commercial building incentive program.
- Develop and disseminate tools for implementing new Federal construction standards.
- Assist 5 states in updating their residential building code to the 1995 MEC and 10 states to update to 1998 MEC.

**II. A.      Funding Table: CODES AND STANDARDS**

Program Activity	FY 1997 Enacted	FY 1998 Enacted	FY 1999 Request	\$ Change	% Change
Building Standards and Guidelines . . . . .	\$ 6,808	\$ 8,423	\$ 12,953	\$ 4,530	54%
Lighting and Appliance Standards . . . . .	5,002	6,000	9,620	3,620	60%
Total, Codes and Standards . . . . .	<u>\$ 11,810</u>	<u>\$ 14,423</u>	<u>\$ 22,573</u>	<u>\$ 8,150</u>	<u>57%</u>

**II. B. Laboratory and Facility Funding Table: CODES AND STANDARDS**

Lawrence Berkeley Lab . . . . .	\$ 2,000	\$ 2,000	\$ 2,000	\$ 0	0%
National Renewable Energy Lab . . . . .	700	700	700	0	0%
Oak Ridge National Lab . . . . .	200	200	200	0	0%
Pacific Northwest Lab . . . . .	2,500	2,500	2,500	0	0%
All Other . . . . .	6,410	9,023	17,173	8,150	90%
Total, Codes and Standards . . . . .	<u>\$ 11,810</u>	<u>\$ 14,423</u>	<u>\$ 22,573</u>	<u>\$ 8,150</u>	<u>57%</u>

### III. Performance Summary: CODES AND STANDARDS

Activity	FY 1997	FY 1998	FY 1999
Building Standards and Guidelines	<p>UPDATE STATE CODES: Implemented a cooperative, co-funded incentive grants program and a technical assistance program to actively assist states in updating and implementing their residential and commercial codes. Developed and implemented programs, tailored to specific states and user groups, to increase awareness of codes and support adoption of codes.</p>	<p>UPDATE STATE CODES: Implement a cooperative, co-funded incentive grants program and a technical assistance program to actively assist states in updating and implementing their residential and commercial codes. Develop and implement programs, tailored to specific states and user groups, to increase awareness of codes and support adoption of codes.</p>	<p>UPDATE STATE CODES: Implement a cooperative, co-funded incentive grants program and a technical assistance program to actively assist states in updating and implementing their residential and commercial codes. Develop and implement programs, tailored to specific states and user groups, to increase awareness of codes and support adoption of codes.</p>
	<p>TRAINING: Provided a variety of materials including Train-the-Trainer activities addressing compliance and enforcement training for architects, engineers, code officials, and home builders. Conducted Regional Workshops to focus on identifying and discussing training and information requirements based on the needs of the regional, state, and local stakeholders.</p>	<p>TRAINING: Provide a variety of materials including Train-the-Trainer and distance learning activities addressing compliance and enforcement training for architects, engineers, code officials, and home builders. Estimate that 500 code officials, designers, and builders will be trained via downlinking and enforcement of the upgraded Model Energy Code and the 1998 federal building energy code, 10 CFR 435. The distance learning</p>	<p>TRAINING: Provide a variety of materials including Train-the-Trainer and distance learning activities addressing compliance and enforcement training for architects, engineers, code officials, and home builders. Estimate that 10,000 code officials, designers, and builders will be trained via downlinking and State enforcement of the upgraded Model Energy Code and the 1998 federal building energy code, 10 CFR 435. The</p>

### III. Performance Summary: CODES AND STANDARDS (Cont'd)

Activity	FY 1997	FY 1998	FY 1999
Building Standards and Guidelines (Cont'd)	<p>training activities will increase overall market penetration by 25 percent. Conduct Regional Workshops to focus on identifying and discussing training and information requirements based on the needs of the regional, state, and local stakeholders.</p> <p>ASSISTANCE: In addition to assisting states upgrade their codes for new residential and commercial buildings, focussed on assisting states to implement the provisions of their code regarding upgrading existing buildings to code standards at time of permitting for renovation and retrofit. Established cooperative funding and agreements with consortia of states, utilities, trade associations, and others to carry out these programs.</p>	<p>distance learning training activities will increase overall market penetration by 25 percent. Conduct Regional Workshops to focus on identifying and discussing training and information requirements based on the needs of the regional, state, and local stakeholders.</p> <p>ASSISTANCE: In addition to assisting states upgrade their codes for new residential and commercial buildings, focus on assisting states to implement the provisions of their code regarding upgrading existing buildings to code standards at time of permitting for renovation and retrofit. Establish cooperative funding and agreements with consortia of states, utilities, trade and professional associations, and representatives of the energy-efficiency industries, energy and environmental advocacy groups, and others interested in accelerating the</p>	<p>distance learning training activities will increase overall market penetration by 25 percent. Conduct Regional Workshops to focus on identifying and discussing training and information requirements based on the needs of the regional, state, and local stakeholders.</p> <p>ASSISTANCE: In addition to assisting states upgrade their code for new residential and commercial buildings, assist states to implement the provisions of their code regarding upgrading existing buildings to code standards at time of permitting for renovation and retrofit. Establish cooperative funding and agreements with consortia of states, utilities, trade and professional associations, and representatives of the energy-efficiency industries, energy and environmental advocacy groups, and others interested in accelerating the</p>



### III. Performance Summary: CODES AND STANDARDS (Cont'd)

Activity	FY 1997	FY 1998	FY 1999
Building Standards and Guidelines (Cont'd)		availability of actual code compliance trainers, financial and in-kind resources, information and materials. As a result of these cooperative arrangements, 10 early implementation state/building industry partnerships will be formed and 10 case studies will be implemented.	availability of actual code compliance trainers, financial and in-kind resources, information and materials. As a result of these cooperative arrangements, 10 new implementation state/building industry partnerships will be formed and 10 case studies will be disseminated. In addition, four DOE/State/local government or building industry partnerships will be initiated. To encourage adoption of updated codes, initiate a CODE+ demonstration project where commercial buildings are constructed, operated and designed to perform better than Standard 90.1R, using the Energy Star rating system developed under the Building Systems Design activities.
	ANALYSIS: Conducted comparative analyses of relative energy efficiency of state residential building codes as compared to the Model Energy	ANALYSIS: Conduct comparative analyses of relative energy efficiency of state residential building codes as	ANALYSIS: Conduct comparative analyses of relative energy efficiency of state commercial building codes as compared to proposed

### III. Performance Summary: CODES AND STANDARDS (Cont'd)

Activity	FY 1997	FY 1998	FY 1999
Building Standards and Guidelines (Cont'd)	<p>Code, 1995 and an analysis of the state relative energy efficiency of state commercial building codes as compared to proposed American Society of Heating, Refrigerating and Air-Conditioning Engineers/Illuminating Engineering Society (ASHRAE/IES) Standard 90.1-1989R.</p> <p>PROCESS: Processed state certifications of compliance updating their energy codes with respect to the Model Energy Code, 1995. Continued to monitor and evaluate the progress of local governments relative to building energy efficiency codes. Reported on the activities related to the requirements of EPACT 101. Processed requests for deadline extensions from states unable to meet the submission date identified in the Federal Register notice 1996. (EPACT Section 101) (\$5,773)</p>	<p>compared to the Model Energy Code, 1998.</p> <p>PROCESS: Process state certifications of compliance updating their energy codes with respect to the Model Energy Code, 1995. Continue to monitor and evaluate the progress of local governments relative to building energy efficiency codes. Report on the activities related to the requirements of EPAct 101. Process requests for deadline extensions from states unable to meet the submission date identified in the Federal Register Notice 1996. (EPACT Section 101) (\$6,523)</p>	<p>ASHRAE/IES Standard 90.1-1989R. Publish Determination concerning whether the Model Energy Code 1998, would improve the efficiency of residential buildings. Process state certifications of compliance updating their energy codes with respect to the Model Energy Code, 1998. Continue to monitor and evaluate the progress of local governments relative to building energy efficiency codes. Report on the activities related to the requirements of EPAct 101. Process requests for deadline extensions from states unable to meet the submission date identified in the Determination. (EPACT Section 101) (\$10,500)</p>

### III. Performance Summary: CODES AND STANDARDS (Cont'd)

Activity	FY 1997	FY 1998	FY 1999
Building Standards and Guidelines (Cont'd)	<p>VOLUNTARY AND FEDERAL ENERGY CODES: Issued proposed rules of energy codes for Federal residential and commercial buildings. Continued support of interim Federal codes for one full year after final Federal codes have been published to facilitate Federal employees and their contractors transition to the new Federal codes. Began analysis of passive and active solar space cooling and heating technologies for inclusion in Federal residential code. Continued support of voluntary energy codes, including analysis of the technical feasibility and economic impacts of amendments to the American Society of Heating, Refrigerating and Air Conditioning Engineers/Illuminating Engineers Society (ASHRAE/IES) Standard 90.1-1989 for commercial buildings and supported the updating and simplification of the Model Energy Code for</p>	<p>VOLUNTARY AND FEDERAL ENERGY CODES: Begin preparation of technical assistance materials such as code compliance and user manuals, as well as various software in support of 1998 Federal codes. Issue final rules of energy codes for Federal residential and commercial buildings. Initiate a national training effort to teach Federal employees and their contractors the provisions of the 1998 Federal codes. Continue support of interim Federal code for one full year after 1998 Federal codes have been published to facilitate transition to the new codes. Continue analysis of passive and active solar space cooling and heating technologies for inclusion in Federal residential code. Continue to support voluntary energy codes, including analysis and response to public comment on the proposed upgrading of ASHRAE/IES Standard 90.1-1989 for</p>	<p>VOLUNTARY AND FEDERAL ENERGY CODES: Prepare and distribute technical assistance materials such as code compliance and user manuals, as well as various software in support of 1998 Federal codes. Implement national training effort to teach Federal employees and their contractors the provisions of the 1998 Federal codes. Issue proposed rules amending the Federal commercial and the Federal residential codes to include passive and active solar space cooling and heating technologies. Continue to support voluntary energy codes, including analysis and responses to public comment on the proposed upgrading of ASHRAE/IES Standard 90.1-1989 for commercial buildings and support for the updating and simplification of the Model Energy Code for residential buildings. Complete development of code compliance</p>

### III. Performance Summary: CODES AND STANDARDS (Cont'd)

Activity	FY 1997	FY 1998	FY 1999
Building Standards and Guidelines (Cont'd)	residential buildings. Prepared and distributed code compliance manuals, builder's guides, and trade-off software to support adoption and implementation of the Model Energy Code, 1995 and ASHRAE/IES Standard 90.1-1989. (EPACT Section 101) (\$1,035)	commercial buildings and support for the updating and simplification of the Model Energy Code for residential buildings. Begin development of code compliance manuals, builder's guides, and trade-off software, to include the use of passive and active solar space cooling and heating technologies, in support of existing voluntary codes. (EPACT Section 101) (\$1,900)	manuals, builder's guides, and trade-off software, to include the use of passive and active solar space cooling and heating technologies, in support of existing voluntary codes. (EPACT Section 101) (\$2,453)
	\$ 6,808	\$ 8,423	\$ 12,953
Lighting and Appliance Standards	TEST PROCEDURES: Conducted research to develop, maintain, simplify, and improve test procedures for appliances. Revised the test procedures to ensure innovative designs can be fairly tested. Processed manufacturer requests for test procedure waivers. Tested appliances as required for enforcement actions. Issued final rules to amend test procedures for	TEST PROCEDURES: Conduct research to develop, maintain, simplify, and improve test procedures for appliances. Revise the test procedures to ensure innovative designs can be fairly tested. Work with international standards organizations particularly those from Canada and Mexico, to harmonize testing so as to reduce testing requirements for manufacturers	TEST PROCEDURES: Conduct research to develop, maintain, simplify, and improve test procedures for appliances. Revise the test procedures to ensure innovative designs can be fairly tested. Work with international standards organizations particularly those from Canada and Mexico, to harmonize testing so as to reduce testing requirements for manufacturers

### III. Performance Summary: CODES AND STANDARDS (Cont'd)

Activity	FY 1997	FY 1998	FY 1999
Lighting and Appliance Standards (Cont'd)	<p>furnaces/boilers, vented home heating equipment and pool heaters, fluorescent and incandescent lamps, clothes washers, kitchen ranges and ovens, and externally vented refrigerators. Published Notices of Proposed Rulemaking (NPR) to incorporate legislated standards and test procedures for plumbing equipment and large electric motors.</p> <p>STANDARDS: Implemented process improvement initiatives. Issued the final rules for energy conservation standards for refrigerator products and for room air conditioners. Continued pro-active role in support of consensus standards organization</p>	<p>and enhance foreign sales of U.S. products. Process manufacturer requests for test procedure waivers. Test appliances as required for enforcement actions. Publish determination regarding test procedures and standards for distribution transformers. Publish final rule to amend test procedures for water heaters, including small and instantaneous water heaters. Issue final rule to incorporate legislated standards and test procedures for plumbing equipment and large electric motors. Publish NPR to amend test procedures for residential central air conditioners/heat pumps.</p> <p>STANDARDS: Implement the new process. Issue the final rule for energy conservation standards for kitchen ranges and ovens. Publish revised NPR for energy efficiency standards for lamp ballasts and water heaters. Revise Advance Notice of Proposed</p>	<p>and enhance foreign sales of U.S. products. Process manufacturer requests for test procedure waivers. Test appliances as required for enforcement actions. Publish final rule for test procedures for residential central air conditioners/heat pumps. Dependent on determination published in FY 1998, publish NPR regarding test procedures for distribution transformers. Publish NPR to incorporate legislated standards and test procedures for commercial HVAC and water heaters. Initiate rulemaking to amend test procedures for dishwashers.</p> <p>STANDARDS: Implementing the new process, issue final rule regarding energy conservation standards for lamp ballasts and water heaters. Publish NPR for energy conservation standards for clothes washers. Publish ANOPR for energy conservation standards</p>

### III. Performance Summary: CODES AND STANDARDS (Cont'd)

Activity	FY 1997	FY 1998	FY 1999
Lighting and Appliance Standards (Cont'd)	<p>in regard to covered commercial products. Continued to work with equipment manufacturers to ensure products are properly certified and that they meet the standards. In cooperation with interested stakeholders began investigating alternative means of accomplishing the goals of the standards program without revising mandatory standards.</p>	<p>Rulemaking (ANOPR) for energy conservation standards for clothes washers. Initiate energy conservation standards rulemaking for residential central air conditioners/heat pumps. Support the consensus standards organization in regard to covered commercial products. Work with equipment manufacturers to ensure products are properly certified and that they meet the standards. Work with interested stakeholders on investigating alternative means of accomplishing the goals of the standards program without revising mandatory standards.</p>	<p>for residential central air conditioners/heat pumps. Initiate energy conservation standards rulemaking for distribution transformers and large electric motors (1-200hp). Initiate determinations regarding test procedures and standards for small electric motors and high intensity discharge (HID) lamps. Support the consensus standards organization in regard to covered commercial products. Begin rulemaking to revise standards, as required by the legislation in response to changes in the consensus standards. Work with equipment manufacturers to ensure products are properly certified and that they meet the standards. With stakeholders, investigate alternative means of accomplishing the goals of the standards program without revising mandatory standards.</p>
	<p>LABELING: Supported voluntary efficiency rating and</p>	<p>LABELING: Support of voluntary efficiency rating and</p>	<p>LABELING: Support voluntary efficiency rating and labeling</p>

**III. Performance Summary:** CODES AND STANDARDS (Cont'd)

Activity	FY 1997	FY 1998	FY 1999
Lighting and Appliance Standards (Cont'd)	labeling programs for commercial office equipment and luminaries. Worked with industry to develop mandatory labeling requirements for EPCa covered commercial products. (NIST, LBNL, PNL, NREL) (\$5,002)	labeling programs for commercial office equipment and luminaries. Work with industry to develop mandatory labeling requirements for EPCa covered commercial products. (NIST, LBNL, PNL, NREL) (\$6,000)	programs for commercial office equipment and luminaries. Work with industry to develop mandatory labeling requirements for EPCa covered commercial products. (NIST, LBNL, PNL, NREL) (\$9,620)
	\$ 5,002	\$ 6,000	\$ 9,620
Codes and Standards Total	\$ 11,810	\$ 14,423	\$ 22,573

BUILDING TECHNOLOGIES  
BUILDING TECHNOLOGY, STATE, AND COMMUNITY SECTOR  
(dollars in thousands)

STATE AND LOCAL PARTNERSHIP PROGRAMS

I. **Mission Supporting Goals and Objectives:**

The goal of the State and Local Partnership Programs is to promote energy efficiency and the adoption of renewable energy technologies among States, municipalities, institutions, and private citizens thereby helping the Nation realize a stronger economy, a cleaner environment, and a more secure future. The State and Local Partnership Programs include the Weatherization Assistance Program, the Competitive Energy Partnerships Program, which includes the Municipal Energy Management Program and the State Energy Program (consolidating the State Energy Conservation Program, the Institutional Conservation Program, as well as the Energy Extension Service, which were formerly separate programs).

- Weatherization Assistance Program (Weatherization): The goal of the Weatherization program is to provide cost-effective energy efficiency services to constituencies that cannot afford the investment and who, without the program, could not benefit from energy efficiency technologies. The DOE Weatherization Assistance Program has long served as the core program for delivering energy conservation services to low-income Americans. The benefits of weatherization contribute to achieving national and social goals including: cleaner air through reduced emissions of criteria pollutants and CO<sub>2</sub>; reduced consumption of imported fuels through reduced residential consumption; reduced demand on other social programs such as fuel assistance, housing, and health care; and implementation of innovative energy conservation technologies and transfer of this technology into the private marketplace. The program's effectiveness is enhanced by the flexibility of DOE weatherization funding, which enables States and local agencies to leverage additional funding from low-income housing programs, utilities, and in the case of weatherization of rental properties, from property owners. A recently completed metaevaluation of 17 State-level evaluations indicates that advanced energy audits and improved practices in weatherizing homes have produced 80 percent higher average energy savings today as compared to the measured savings in 1989. The Weatherization Assistance Program benefit/cost ratio for energy savings alone is up from 1.06 in 1989 to 1.79 in 1996. The benefit to society, which includes employment, health and safety and other nonenergy effects, is more than double the cost of the program.



I. **Mission Supporting Goals and Objectives:** STATE AND LOCAL PARTNERSHIP PROGRAMS (Cont'd)

In FY 1999, Weatherization's performance will be measured in the following ways:

- Number of low-income homes weatherized (estimated 78,200)
- Number of persons directly and indirectly employed to conduct weatherization activities (estimated 8,013 direct jobs created and 3,526 jobs indirectly supported)
- Amount of atmospheric carbon reduced (estimated .043 MMTCE annually)
- Energy saved (estimated annual savings: 2.5 Tbtu)

Accomplishments:

- Weatherized 63,335 homes in FY 1998
- Annual energy savings of 2 Tbtu
- Additional funds leveraged will double the above figures
- Carbon emission avoidance of .035 MMTCE in FY 1998
- State Energy Program (SEP): The goal of SEP is to provide a supportive framework with sufficient flexibility to enable the States to address their own energy priorities in concert with national priorities. Traditionally, State Energy Offices have been able to leverage their Federal funds for this program at the rate of 4 non-Federal dollars for each Federal dollar received, and have leveraged as much as 13 to 14 non-Federal dollars for each Federal dollar for some activities. Maintaining a strong State Energy Office capacity, and the delivery network these offices provide, is essential to the achievement of national energy objectives. The State offices also coordinate energy, environmental, and economic policies in response to the new challenges of the 21st century. States have a primary key role in the development and deployment of sustainable technologies and are focusing on the following: alternative fuels and alternative fueled vehicles, efficient electric motors and drives, power production from renewable resources, integrated resource planning, industrial waste minimization and waste-to-energy technologies, building efficiency, and solar industrial process heat, just to name a few.

I. **Mission Supporting Goals and Objectives:** STATE AND LOCAL PARTNERSHIP PROGRAMS (Cont'd)

Because of the unique capabilities of the State Energy Offices, EERE's End-Use Sector offices partner with States to deploy key EERE technologies through the Special Projects portion of SEP. Over the past three years, the End-Use Sector offices have funded \$35 million through SEP for these technology deployment activities.

In FY 1999, this program will continue to increase the extent to which federal, state and local governments work with other public and private sector entities, including schools and hospitals, to achieve widespread adoption of available energy efficiency and renewable energy technologies, and to demonstrate the use of emerging technologies which could be of benefit to all sectors of the economy. This includes working with the building industry and consumers for improvements in the nation's residential energy efficiency.

In FY99 SEP performance will be measured in the following ways:

- Amount of non-federal funds invested in energy efficiency and renewable energy activities. Each SEP dollar is expected to leverage at least \$4 in state, utility and other private sector funds in FY 1999
- Number of jobs created. It is estimated that SEP activities will create or support 6,105 jobs in FY 1999
- Energy saved. It is estimated that SEP activities will save 5.7 TBtu in FY 1999
- Carbon emissions prevented (estimated to be .093 MMTCE in FY 1999)

SEP accomplishments:

- States continued to increase resources devoted to expanding market opportunities for energy efficiency and renewable energy technologies, e.g., State Energy offices act as catalysts for public/private partnerships that encourage technology and deployment. For example, such cooperative efforts have led to successes in manufacturing, recycling, and the increasing use of energy efficient motors by industry.
- Creation of 4,991 jobs in FY 1998
- Energy savings of 4.7 TBtu in FY 1998

I. **Mission Supporting Goals and Objectives:** STATE AND LOCAL PARTNERSHIP PROGRAMS (Cont'd)

- Carbon emission avoidance of .076 MMTCE in FY 1998
- Each SEP dollar leveraged at least \$4 in non-DOE funds
- Competitive Energy Partnerships: The goal of Municipal Energy Management Program (MEMP) is to demonstrate innovative and realistic technologies, strategies, and methods that help urban America become more energy efficient and environmentally responsible. This program focuses on the application of new technologies/techniques and management practices to deliver local energy services more efficiently, improve the local revenue base, and foster community-wide energy sustainability. Grants to conduct urban applied research and demonstration projects are awarded through an annual competitive solicitation process to ensure the best deployment of resources. An additional request of \$5 million will permit extension of competitive grants to support community-wide partnerships, involving private sector as well as public sector partners, to target sustainable energy opportunities that reduce criteria pollutants and greenhouse gases, while improving the quality of life, environmental health, infrastructure, and economic vitality of local communities.

The performance of the Competitive Energy Partnerships funded in FY 1999 will be measured by:

- Reduction in greenhouse gases (.016 MMTCE annually)
- Energy savings (1.02 Tbtu annually)
- Jobs created (1,089 jobs)

MEMP accomplishments in FY 1998:

- Creation of 265 jobs
- Energy savings of 0.25 Tbtu
- Carbon emission avoidance of .004 MMTCE
- Each MEMP dollar leveraged \$4 in non-DOE funds

I. **Mission Supporting Goals and Objectives:** STATE AND LOCAL PARTNERSHIP PROGRAMS (Cont'd)

The goal of State and Local Partnership Programs is to accelerate the deployment of renewable energy and energy efficiency technologies while providing management and administrative support for the State and Local Partnership and Targeted Deployment Programs.

Performance will be measured by:

- An increase to 90 percent of all State energy program offices which are linked to regional support offices' electronic mail
- An increase to 85 percent of all State energy program offices which are full participants in use of the SAGA (Systems Approach to Grant Administration) system
- Level of customer satisfaction with the service with State and Local Partnership Programs

Accomplishments:

- Successful implementation of new program structure
- 70 percent of States full participants in use of the SAGA system
- Successful implementation of Special Projects portion of SEP, awarding \$11 million from and in conjunction with other EERE research, development, demonstration, and outreach efforts to support State and local EERE technology deployment and technology access efforts.

**II. A. Funding Table: STATE AND LOCAL PARTNERSHIP PROGRAMS**

Program Activity	FY 1997 Enacted	FY 1998 Enacted	FY 1999 Request	\$ Change	% Change
Weatherization Assistance Program . . . . .	\$ 120,845	\$ 124,845	\$ 154,100	\$ 29,255	23%
State Energy Program . . . . .	29,000	30,250	37,000	6,750	22%
Competitive Energy Partnerships . . . . .	1,576	1,600	6,600	5,000	313%
Total, State and Local Partnership Programs . . .	<u>\$ 151,421</u>	<u>\$ 156,695</u>	<u>\$ 197,700</u>	<u>\$ 41,005</u>	<u>26%</u>

**II. B. Laboratory and Facility Funding Table: STATE AND LOCAL PARTNERSHIP PROGRAMS**

All Other . . . . .	<u>151,421</u>	<u>156,695</u>	<u>197,700</u>	<u>41,005</u>	<u>26%</u>
Total, State and Local Partnership Programs . . . . .	<u>\$ 151,421</u>	<u>\$ 156,695</u>	<u>\$ 197,700</u>	<u>\$ 41,005</u>	<u>26%</u>

### III. Performance Summary: STATE AND LOCAL PARTNERSHIP PROGRAMS

Activity	FY 1997	FY 1998	FY 1999
Weatherization Assistance Program	<p>Continue level of training and technical assistance activities: improve techniques to identify and install the most cost-effective weatherization measures; analyze health/safety issues; promote the use of advanced residential technologies, including those from DOE's R&amp;D efforts. (NREL, ORNL, PNL) (\$2,000)</p> <p>WEATHERIZATION ASSISTANCE: Provide State grants to weatherize 61,120 low-income homes. (\$118,845)</p>	<p>Continue level of training and technical assistance activities: improve techniques to identify and install the most cost-effective weatherization measures; analyze health/safety issues; promote the use of advanced residential technologies, including those from DOE's R&amp;D efforts. (\$1,900)</p> <p>WEATHERIZATION ASSISTANCE: Provide State grants to weatherize 63,335 low-income homes. (\$122,945)</p>	<p>Continue level of training and technical assistance activities: improve techniques to identify and install the most cost-effective weatherization measures; analyze health/safety issues; promote the use of advanced residential technologies, including those from DOE's R&amp;D efforts. (\$2,300)</p> <p>WEATHERIZATION ASSISTANCE: Provide State grants to weatherize 78,200 low-income homes, 1/3 of 1 percent of the eligible homes nationwide. The relative scarcity of funds means that only the very neediest can be served. Latest performance data indicates that every dollar invested in the program yields \$1.80 in benefits. (\$151,800)</p>
	\$ 120,845	\$ 124,845	\$ 154,100
State Energy Program	STATE ENERGY PROGRAM: In a consolidated grant type format, the State Energy Program	STATE ENERGY PROGRAM: Provide grants to 50 States, D.C. and five territories for energy	STATE ENERGY PROGRAM: Provide grants to 50 States, D.C. and five territories for energy

**III. Performance Summary: STATE AND LOCAL PARTNERSHIP PROGRAMS (Cont'd)**

Activity	FY 1997	FY 1998	FY 1999
State Energy Program (Cont'd)	will provide grants to 50 States, D.C. and five territories for energy efficiency programs including schools and hospitals. The new consolidated grant approach simplifies administrative and related functions associated with the separate programs which it replaces and provides States increased flexibility to address their own priorities. Continue to promote broad-based program to support innovative approaches, such as third party financing, revolving loan funds, integrated resource planning, and energy technology commercialization services. (\$29,000)	efficiency programs. Continue to promote broad-based program to support innovative approaches, such as incentive funding, revolving loan funds, integrated resource planning, and energy technology commercialization services. Increase program emphasis on technology transfer and on partnering with States to explore leveraging strategies. In addition to basic support provided under Program Direction account, provide technical assistance/training with focus on developing State-level capabilities to use collaborative partnerships for EE/RE utilization. (\$30,250)	efficiency programs. Continue to promote broad-based program to support innovative approaches, such as incentive funding, revolving loan funds, integrated resource planning, and energy technology commercialization services. Increase program emphasis on technology transfer and on partnering with States to explore leveraging strategies. For example, the State of Wisconsin's Daylighting Retrofit Demonstration Program shows the cost effectiveness and feasibility of active daylighting technologies. In addition to basic support provided under Program Direction account, provide technical assistance/training with focus on developing State-level capabilities to use collaborative partnerships for EE/RE utilization. Each federal dollar allocated to SEP leverages \$4 in non-federal funds for energy efficiency programs. Involve States in providing better

**III. Performance Summary: STATE AND LOCAL PARTNERSHIP PROGRAMS (Cont'd)**

Activity	FY 1997	FY 1998	FY 1999
State Energy Program (Cont'd)			performance measures for State SEP activities. (\$37,000)
	\$ 29,000	\$ 30,250	\$ 37,000
Competitive Energy Partnerships			Provide technical and financial support to communities to improve energy efficiency and the use of renewable energy community-wide. Three key activities will be undertaken. First, competitively solicit innovative proposals from communities, with public and private partners. The successful proposals will include practical, tangible techniques for making communities more prosperous and healthy such as: the integration of efficient and renewable technologies using a building systems engineering approach; overcoming barriers to the rapid adoption of new efficient technologies; and reducing mobility needs through refinements in land use planning. Communities will also provide feedback to advance the next



**III. Performance Summary: STATE AND LOCAL PARTNERSHIP PROGRAMS (Cont'd)**

Activity	FY 1997	FY 1998	FY 1999
Competitive Energy Partnerships (Cont'd)			generation of applied research. Second, aggregate community-wide markets and refine performance-based financing mechanisms to reduce barriers to first cost and perceived risk. Third, provide technical assistance and training on the adoption of new technologies and techniques for improving energy efficiency. This effort is based on the experience that communities need flexibility to design energy saving programs that respond to their own circumstances and goals. Partners can include business improvement districts, homebuilders, retailers, public institutions, non-profits, State governments, and the private sector. "An example on this might be working with public and private partners to share lessons learned by Federal Energy Saving Performance Contracting to finance energy conservation measures, especially in a deregulated electric utility market". Projects will be carefully

**III. Performance Summary: STATE AND LOCAL PARTNERSHIP PROGRAMS (Cont'd)**

Activity	FY 1997	FY 1998	FY 1999
Competitive Energy Partnerships (Cont'd)	Through the Municipal Energy Management Program, conducted (co-fund) approximately 18 applied research projects in buildings, municipal processes, transportation, and sustainable urban energy systems. Provide technical assistance to local jurisdictions in replicating successful projects. Continue regional workshops and dissemination of information to a broad urban audience. (Urban Consortium) (\$1,576)	Through the Municipal Energy Management Program, conduct (co-fund) approximately 18 applied research projects in buildings, municipal processes, transportation, and sustainable urban energy systems. Provide technical assistance to local jurisdictions in replicating successful projects. Continue regional workshops and dissemination of information to a broad urban audience. (Urban Consortium) (\$1,600)	evaluated on short and medium term energy and dollar savings, job creation, and benefits to the environment. (TBD) (\$5,000)  Through the Municipal Energy Management Program, conduct (co-fund) approximately 18 applied research projects in buildings, municipal processes, transportation, and sustainable urban energy systems. Provide technical assistance to local jurisdictions in replicating successful projects. Continue regional workshops and dissemination of information to a broad urban audience. (Urban Consortium) (\$1,600)
	\$ 1,576	\$ 1,600	\$ 6,600
State and Local Partnership Programs Total	\$ 151,421	\$ 156,695	\$ 197,700

BUILDING TECHNOLOGIES  
BUILDING TECHNOLOGY, STATE, AND COMMUNITY SECTOR  
(dollars in thousands)

MANAGEMENT AND PLANNING

I. **Mission Supporting Goals and Objectives:**

MISSION

The Office of Building Technology, State and Community Programs (BTS) is responsible for increasing the efficiency of energy use and encouraging the use of renewable rather than conventional energy in buildings by developing new, cost-effective technologies and encouraging the full use of those currently available. The mission of the Office's Management and Planning program is to provide the information needed for defining the set of activities that will most effectively achieve sector goals; for determining the appropriate level of resources consistent with effective execution of those activities; for ensuring that the desired results are achieved; and for enabling other agencies and the private sector to understand these activities in their decision making. Management and Planning also provides the personnel to conduct sector programs.

The overall goal of the Management and Planning program area is a well-planned and managed program for the buildings sector, a program that will achieve sector goals in the most cost-effective manner possible. The report of the Task Force on Strategic Energy Research and Development of the Secretary of Energy Advisory Board, "Energy R&D: Shaping our Nation's Future in a Competitive World", recognizes the importance of both effective planning and management in the conduct of federal energy programs, and stresses the need for more emphasis in these areas.

STRATEGY

Effective management requires efficient organizational design, adequate human resources, sufficient information, and good communication, both within the organization and with outside parties. A solid analytical foundation is basic to understanding the potential for increasing the penetration of energy efficient and renewable technologies in the building sector, and for achieving the correct balance and direction of programmatic activities. The organization maintains strong capabilities in data and information, model development, and analysis to ensure that decisions regarding program direction and resource allocation are guided by the best possible information. Analytical capabilities

I. **Mission Supporting Goals and Objectives:** MANAGEMENT AND PLANNING (Cont'd)

and the supporting data base are continually refined and strengthened to improve the information available for program guidance decisions and to better evaluate the energy, economic, and environmental impacts of programmatic alternatives.

FY 1999 FUNDING REQUEST

Management and Planning provides analytical support and management staff to the buildings sector programs. It consists of: (1) Evaluation, Planning and Analysis which is responsible for the data, analytical tools, and analyses required for program planning, prioritization, and management; and (2) Program Direction, which supports the personnel to manage the sector programs. The FY 1999 funding request is \$14.7 million. Details of the request for each activity are given below.

- The FY 1999 Request for Evaluation, Planning and Analysis is for collecting and processing technology and sector data, modeling and tools development, analytical studies and planning support, support for customer-focused services for state and local grants programs, regional planning and services to in-state customers, connecting states to the electronic program information systems, and helping states access other resources.
- The FY 1999 request for Program Direction will provide salaries, benefits, travel, and support for FTEs to manage Buildings Technologies, State and Community Programs. 75 FTEs will be located at DOE headquarters in Washington.

PROGRAM BENEFITS

Benefits from a successful Management and Planning program are reflected in progress toward achieving the overall sector goals which are reflected in energy and consumer cost savings, employment increases, balance of trade improvements, and emissions reductions. While the Management and Planning program does not directly achieve these benefits, it provides information, guidance, and direction necessary for the operating programs to realize them. The program also develops information useful to the private sector in assessing the costs and benefits of improving the efficiency of energy use in buildings.

PERFORMANCE MEASURES

Accomplishment of the following performance measures during FY 1999 will indicate success for the Management and Planning program.

- Credible estimates of the benefits expected from BTS's proposed FY 2000 activities, as reflected in the evaluations of external reviewers. Development of performance measures/milestones as required by the Government Performance and Results Act (GPRA), to measure annual progress toward achievement of BTS program benefits.

I. **Mission Supporting Goals and Objectives:** MANAGEMENT AND PLANNING (Cont'd)

- Effective response to the mandates of the GPRA in the areas of benefit estimation and evaluation;
- Implementation of the recommendations of the President's Committee of Advisors on Science and Technology contained in the report Federal Energy Research and Development for the Challenges of the Twenty-First Century, including portfolio analysis, increased focus on international activities, and assisting with the development of a cogent plan for an expanded buildings R&D program;
- Assistance with the development and implementation of the evolving BTS Strategic Plan;
- Maintenance and improvement of the Office's analytical capability, especially in the areas of planning and the development of background information to support quick response tasks.

In FY 1999 the Management and Planning program will continue to provide the necessary metrics for evaluating overall program success, monitoring progress toward the achievement of sector goals, and evaluating changes in program emphasis as appropriate.

**II. A. Funding Table:** MANAGEMENT AND PLANNING

Program Activity	FY 1997 Enacted	FY 1998 Enacted	FY 1999 Request	\$ Change	% Change
Evaluation and Planning . . . . .	\$ 10,409	\$ 5,500	\$ 7,268	\$ 1,768	32%
Program Direction . . . . .	6,924	7,350	7,450	100	1%
Capital Equipment . . . . .	0	0	0	0	0%
Total, Management and Planning . . . . .	<u>\$ 17,333</u>	<u>\$ 12,850</u>	<u>\$ 14,718</u>	<u>\$ 1,868</u>	<u>15%</u>

**II. B. Laboratory and Facility Funding Table:** MANAGEMENT AND PLANNING

Brookhaven National Lab . . . . .	\$ 450	\$ 400	\$ 400	\$ 0	0%
Lawrence Berkeley Lab . . . . .	800	600	600	0	0%
National Renewable Energy Lab . . . . .	200	100	100	0	0%
Oak Ridge National Lab . . . . .	500	100	100	0	0%
Pacific Northwest Lab . . . . .	1,300	1,300	1,300	0	0%
All Other . . . . .	<u>14,083</u>	<u>10,350</u>	<u>12,218</u>	<u>1,868</u>	<u>18%</u>
Total, Management and Planning . . . .	<u>\$ 17,333</u>	<u>\$ 12,850</u>	<u>\$ 14,718</u>	<u>\$ 1,868</u>	<u>15%</u>

### III. Performance Summary: MANAGEMENT AND PLANNING

Activity	FY 1997	FY 1998	FY 1999
Evaluation and Planning	<p>TECHNOLOGY AND SECTOR DATA: Merged OBT and State and Community Programs Data. Updated and expanded the core information data base to include information on program successes, renewable technologies, efficient technologies for commercial buildings, and building sector imports and exports. Upgraded data on the performance of energy-efficient commercial buildings and to compare their predicted and actual performance. Developed the Buildings Roadmap System to improve the efficiency of data retrieval and manipulation. Compiled standardized, current technology characterization information for advanced building technologies and materials. (\$800)</p> <p>MODELING AND TOOLS: Cooperated with the Energy</p>	<p>TECHNOLOGY AND SECTOR DATA: Develop and upgrade data required for the planning and evaluation of buildings RD&amp;D and grants programs. Update and expand the Core Databook and Core Presentation Catalog to include information on program successes, renewable technologies, energy-efficient technologies, and building sector imports and exports. Upgrade data on the performance of energy-efficient residential buildings and compare their predicted and actual performance. Compile standardized, current technology characterization information for advanced building technologies and materials. Expand database on costs and performance of options for improving the efficiency and expanding the use of renewables in residential buildings. Continue collaboration and cooperation with EIA in end-use data gathering and analysis. (\$800)</p> <p>MODELING AND TOOLS: Cooperate with the Energy</p>	<p>TECHNOLOGY AND SECTOR DATA: Develop, organize, interpret and disseminate the basic data required as input to energy policy formulation for buildings and the planning, management and evaluation of the BTS program. This data includes building and technology characteristics, disaggregated information on energy use in the buildings sector [by end-use, fuel, economics, demographic parameters, etc.], environmental data, building industry characteristics, and market data. Where necessary, develop data [e.g., measured data on energy use]. In other cases, gather data from other sources, and interpret and compile in a useful form. Continue collaboration and cooperation with EIA in end-use data gathering and analysis. (\$1,068)</p> <p>MODELING AND TOOLS: Cooperate with the Energy</p>

### III. Performance Summary: MANAGEMENT AND PLANNING (Cont'd)

Activity	FY 1997	FY 1998	FY 1999
Evaluation and Planning (Cont'd)	<p>Information Agency in improving the building sector representations in the National Energy Modeling System (NEMS) and supported incorporation of such advanced technologies as the GAX heat pump, building-integrated PV, spectrally-selective glazings, sulfur lamps and passive and active solar heating into the model. Continued development of a standard market penetration methodology for use in evaluation of emerging building technologies. (\$449)</p> <p>ANALYTICAL STUDIES AND PLANNING SUPPORT: Continued studies of potential international markets for U.S. energy-efficient building technologies. Updated retrospective information on benefits achieved by past OBT and state and community programs ("The Bottom Line"). Updated and refined estimates of benefits expected from current program activities ("Quality Metrics"). Provided information and inputs for planning and budgeting. Quantified potential cost-effective renewable contributions to meeting</p>	<p>Information Administration and support incorporation of such advanced technologies as the GAX heat pump, building-integrated PV, spectrally-selective glazings, sulfur lamps and passive and active solar heating into the NEMS model. Continue a standardized market penetration approach for emerging building technologies. (\$300)</p> <p>ANALYTICAL STUDIES AND PLANNING SUPPORT: Provide credible estimates of the benefits of BTS activities, as reflected in the evaluations of external reviewers. Compile the BTS contributions to the EE Strategic and Multi-Year Plans, Budget Requests, and other planning documents. Improve understanding of risk and its role in program planning. Update and expand information on consumer economics. Analyze and evaluate the BTS program portfolio under a variety of future scenarios to optimize performance,</p>	<p>Information Administration to refine and update buildings energy use data. Support incorporation of data on advanced technologies. Maintain computer software to allow easy access to and manipulation of buildings characteristics and consumption data. (\$300)</p> <p>ANALYTICAL STUDIES AND PLANNING SUPPORT: Conduct topical analyses on research needs and opportunities, international technology development, potential carbon savings and associated costs, impacts of utility deregulation, and other subjects as appropriate. Activities supported will include portfolio analysis, GPRA evaluation and benefits analysis, analysis of emerging trends in buildings energy use, estimates of potential carbon savings, and implications of utility deregulation. Design and implement</p>



### III. Performance Summary: MANAGEMENT AND PLANNING (Cont'd)

Activity	FY 1997	FY 1998	FY 1999
Evaluation and Planning (Cont'd)	energy service demands in buildings. (\$710)	accounting for time frame, risk, environmental impacts, and costs. (\$700)	an evaluation process for all BTS programs and services to more effectively identify opportunities to improve resource allocations. (\$1,600)
	<p>SUPPORT FOR STATE AND LOCAL GRANT PROGRAMS: Responded to state requests for assistance in implementing consolidated state grants, in conducting regional planning and in providing high quality services to in-state customers; increased the number of states connected electronically to the program information system; and helped states access energy-related resources of other Federal agencies. Also supported program oversight, provided advisory board support and responded to Congressionally-mandated reporting requirements. (\$3,450)</p>	<p>SUPPORT FOR STATE AND LOCAL GRANT PROGRAMS: Provide customer-focussed services in the state and local grant programs. Funds will be used to: respond to state requests for assistance in implementing consolidated state grants, in conducting regional planning and in providing high quality services to in-state customers; increase the number of states connected electronically to the program information system; and help states access energy-related resources of other Federal agencies. Also support program oversight, provide advisory board support and respond to Congressionally-mandated reporting requirements. (\$3,700)</p>	<p>SUPPORT FOR STATE AND LOCAL GRANT PROGRAMS: Continue to provide customer-focussed services in the state and local grant programs. Respond to state requests for assistance in implementing state grants, in conducting regional planning and in providing high quality services to in-state customers; increase the number of states connected electronically to and upgraded, Windows-based program information system; cooperatively develop performance metrics with States; and help states access energy-related resources of other Federal agencies. Support program oversight, provide advisory board support and respond to Congressionally-mandated reporting requirements. (\$4,300)</p>

**III. Performance Summary:** MANAGEMENT AND PLANNING (Cont'd)

Activity	FY 1997	FY 1998	FY 1999
Evaluation and Planning (Cont'd)	Provided support to the Energy Information Administration (EIA) for existing activities. These funds were required to support the core EIA data and modeling activities needed to set energy efficiency program needs and measure program results. This reimbursement included the following programs: efficiency and renewables data collection, and analysis, end-use energy consumption surveys, greenhouse gas data collection studies, mid-term energy demand modeling, and integrated end-use energy data compilation. This approach provided for much closer and effective coordination and prioritization of data collection, analysis, and evaluation needs. It also assisted in ensuring consistency of analyses, improving the utilization of key information for both strategic and program level decisionmaking and providing increased value for external users of the information. (\$5,000)	These activities previously funded here in FY 1997, are funded under EIA through direct appropriation. (\$0)	No Activities. (\$0)
	\$ 10,409	\$ 5,500	\$ 7,268

**III. Performance Summary: MANAGEMENT AND PLANNING (Cont'd)**

Activity	FY 1997	FY 1998	FY 1999
Program Direction	<p>The following is a breakdown of the funding by Object Class:</p> <p>11.9 Personnel compensation \$5,415</p> <p>12.1 Civilian personnel benefits \$1,150</p> <p>21.0 Travel and transportation of persons \$354</p> <p>25.2 Other services \$5</p> <p>Provided salaries, benefits, travel, support, and realignment costs for 81 FTEs to manage Building Technology, State, and Community programs, including responsibilities under the Energy Policy Act of 1992. Funding provided staffing requirements to conduct OBT and OTFA programs, as well as costs for relocations and transfers among locations in the field in accordance with strategic alignment. FEMP requirements are now identified in its separate section of the budget. (\$6,924)</p> <p>\$ 6,924</p>	<p>The following is a breakdown of the funding by Object Class:</p> <p>11.9 Personnel compensation \$5,365</p> <p>12.1 Civilian personnel benefits \$1,176</p> <p>21.0 Travel and transportation of persons \$620</p> <p>25.2 Other services \$189</p> <p>Provide salaries with cost of living increase, benefits, travel, support, and realignment costs for 74 FTEs to manage Building Technology, State, and Community programs, including responsibilities under the Energy Policy Act of 1992. The request for other services supports employee training, permanent change of station moves, and a contingency. Funding will provide staffing requirements to conduct BTS programs. (\$7,350)</p> <p>\$ 7,350</p>	<p>The following is a breakdown of the funding by Object Class:</p> <p>11.9 Personnel compensation \$5,465</p> <p>12.1 Civilian personnel benefits \$1,176</p> <p>21.0 Travel and transportation of persons \$620</p> <p>25.2 Other services \$189</p> <p>Provide salaries with cost of living increase, benefits, travel, support, and realignment costs for 75 FTEs to manage Building Technology, State, and Community programs, including responsibilities under the Energy Policy Act of 1992. The request for other services supports employee training, permanent change of station moves, and a contingency. Funding will provide staffing requirements to conduct BTS programs. (\$7,450)</p> <p>\$ 7,450</p>

**III. Performance Summary:** MANAGEMENT AND PLANNING (Cont'd)

Activity	FY 1997	FY 1998	FY 1999
Capital Equipment	Limited capital equipment acquired primarily to support the BTS research and development activities. These purchases were made from operating expense funds according to established reprogramming guidelines. (\$0)	Limited capital equipment will be acquired primarily to support the BTS research and development activities. These purchases will be made from operating expense funds according to established reprogramming guidelines. (\$0)	Limited capital equipment will be acquired primarily to support the BTS research and development activities. These purchases will be made from operating expense funds according to established reprogramming guidelines. (\$0)
	\$ 0	\$ 0	\$ 0
Management and Planning Total	\$ 17,333	\$ 12,850	\$ 14,718